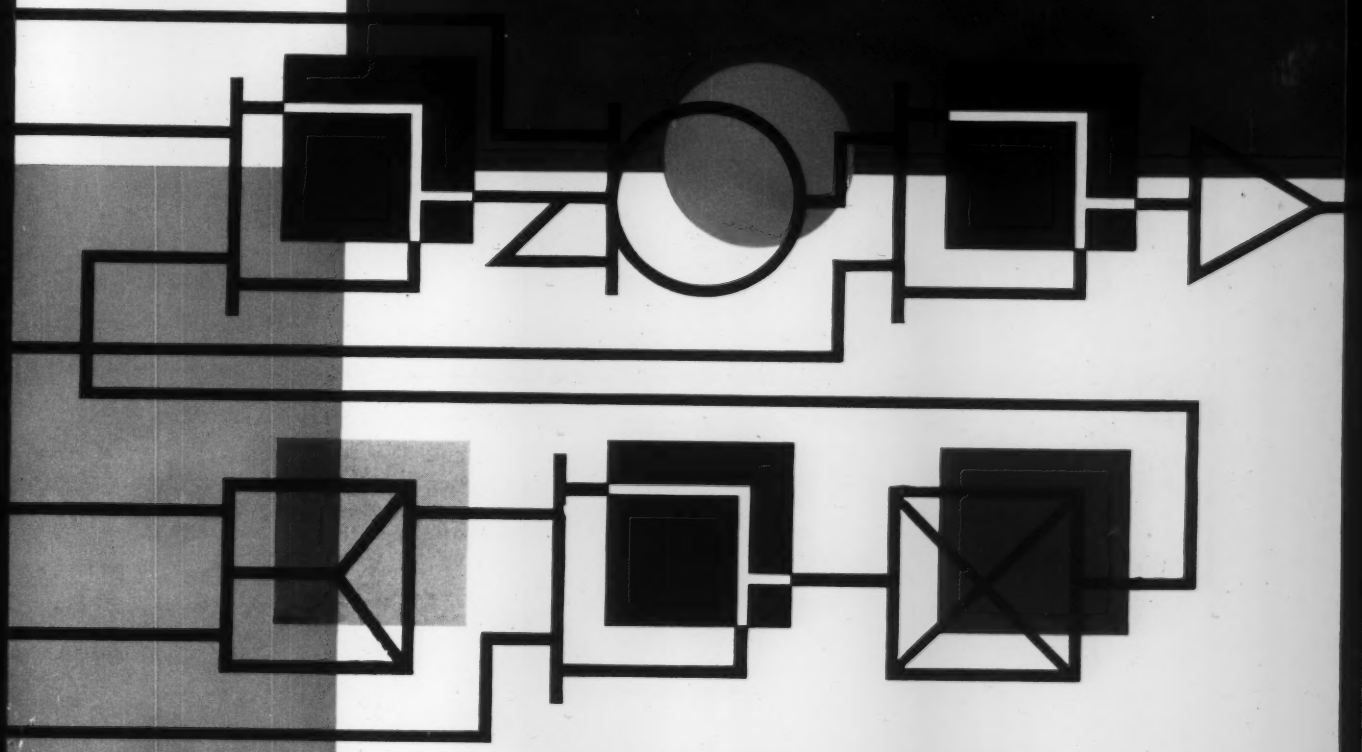
OCTOBER 1, 1959

MACHINE DESIGN

A PENTON PUBLICATION SEMIWEEKLY



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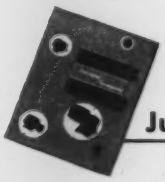

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STOCK MOTOR bulletin... 12 pages of photos, cut-aways, drawings, tables, and charts describe 300 different Bodine Motors, 1/6 to 1/2000 hp.... most of which are carried in stock by your Bodine Distributor. Ask him for a copy of Bulletin "S-1," or consult your Sweet's Product Design file.

...the power behind the leading products

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Circle 404 on Page 19

For advanced fuel...hydraulic...lube systems,

New materials prove ideal in handling temperature extremes −350° F. to +750° F.

Working with two remarkably versatile elastomers, C/R Sirvene engineers are producing flexible molded parts for many vital fuel, lubricating, hydraulic and pneumatic systems. One, Viton-A*, can be compounded to produce parts that function dependably at 600° F., and for short periods up to 750° F. The other important feature of Viton compounds is their excellent resistance to corrosive chemicals, chlorinated solvents as well as both synthetic and petroleum base fuels and lubes. At the other extreme, C/R compounded Silastic LS-53** parts are providing low temperature operation down to -80° F. They also exhibit excellent resistance to synthetic and petroleum base fluids up to 350° F., and function well in propane up to 500° F. For temperatures as low as -350° F., C/R recommends Teflon* compounds.

C/R Sirvene engineers have an intimate knowledge of these elastomers. They also have perfected special techniques in processing which still further improve the physical properties of the molded parts. If your problem involves high or low temperatures, close tolerances, and compatibility in advanced design fuel, lubricant or hydraulic systems, get in touch with us at once. We have the skill and the facilities to help you.

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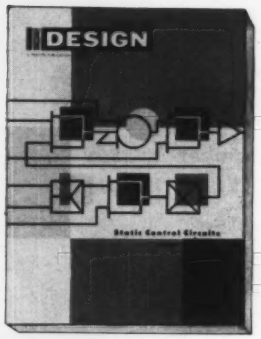

Front Cover: Using AND, OR, NOT and MEMORY circuit elements, George Farnsworth has constructed a simplified, but "real" circuit. The original circuit can be found in Example 2 of Ed Rudisill's article, which starts on Page 116.

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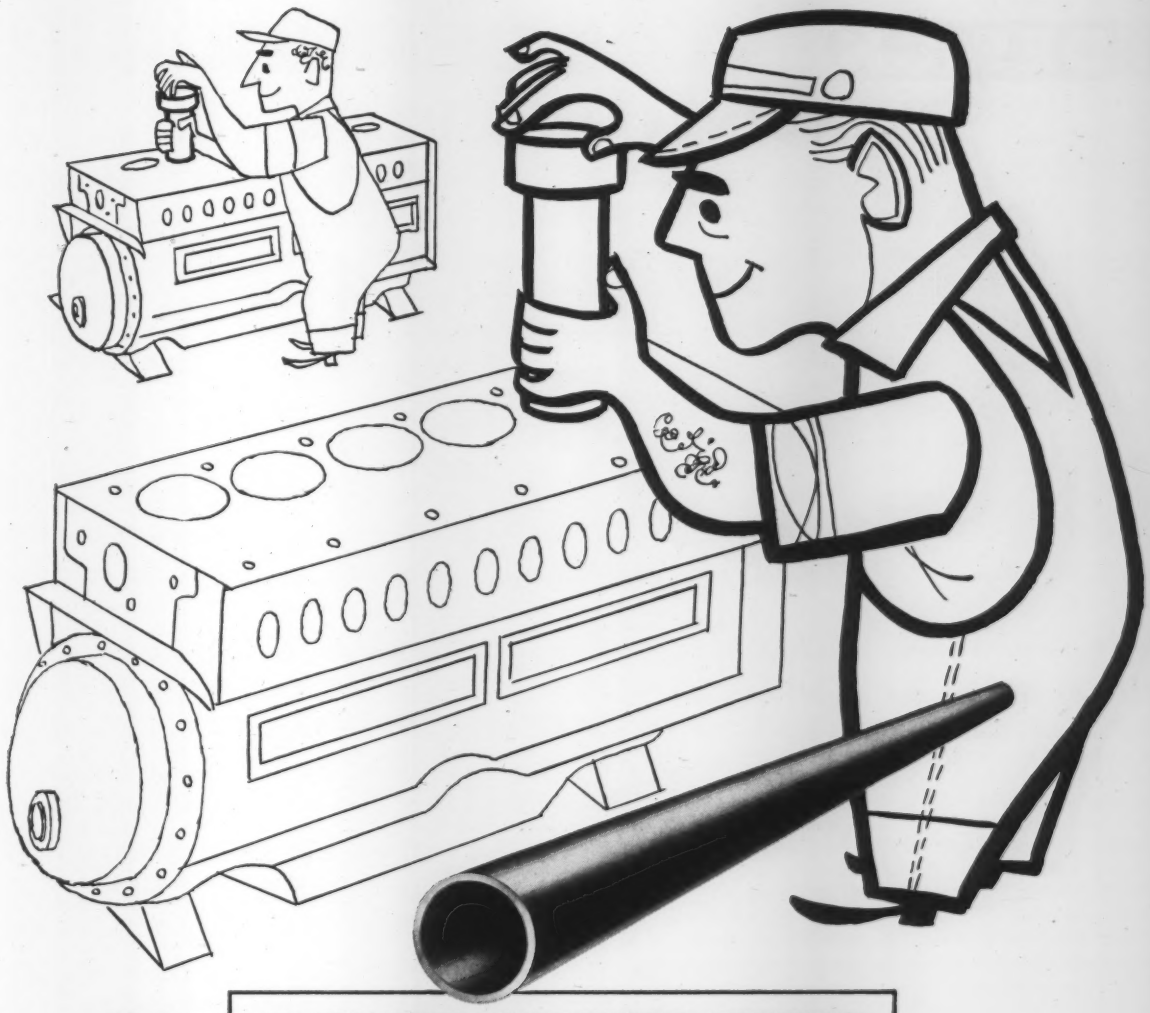

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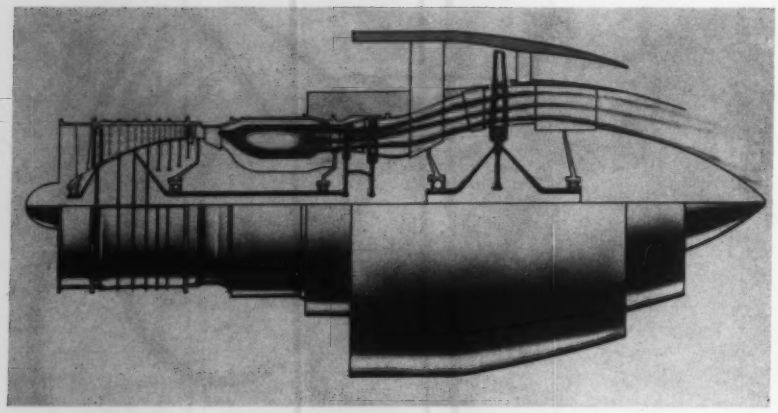
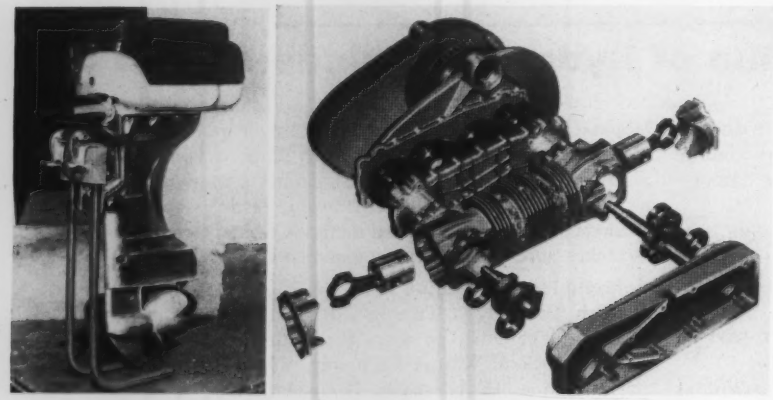


Aft Fan Engine for Light Aircraft

New subsonic turbofan is a 4000-lb thrust version of General Electric's J85 turbojet mated to an aft fan unit. It is designed to give light and medium weight airplanes the performance and economy benefits demonstrated by the larger aft fan engines. Current GE plans call for producing flightworthy engines by mid-1961 and obtaining FAA certification in early 1962. The new engine will provide higher gross weight take-off capability, 20 per cent more range, and superior hot-day performance. Its 0.69 specific fuel consumption and increased thrust mean greater operating economy, improved short field take-off, and more rapid climb. It weighs only 585 lb and has a diam of only 33 in. max. It is designed to operate most efficiently at speeds from Mach 0.5 to 0.9.



Little Diesel Goes to Sea

Diesel outboard motors, developed by American Marc Inc., Inglewood, Calif., are reportedly both light and efficient. Made of aluminum wherever possible (including cylinder blocks) and designed with a minimum number of parts, the single-cylinder, two-piston opposed, air or water-cooled motors eliminate troubles since they have no magnetos, spark plugs, carburetors, valves, etc., and present no gasoline-fire hazard. They are available in 7½, 15, and 22 hp models.

Meteor Trails Bounce Signals For Long-Distance Radio

Long-Range Radio System Sends, Receives 4800 wpm

WASHINGTON—Millions of tiny meteors enter the earth's atmosphere every day, only to burn up before they fall to the ground. Heat due to air friction vaporizes the meteoric material and creates a trail of electrons and ionized atoms stretching behind for about 15 miles. This trail reflects radio waves, and causes short-time enhancement of radio signals. National Bureau of Standards Scientists have found a way to use such meteor trails to send long-distance radio messages.

The experimental radio communication system, three years in development, can handle messages at speeds as high as 4800 wpm—80 times the present speed of transmission by teletype. Bounced messages are free from ionospheric disturbances which affect normal long-distance radio communication, even with low power and small antennas.

In the NBS experiments, two stations were used. Transmitters were left on continuously, even when no message was being sent. Control equipment at each station determined when conditions were acceptable for message transmission, depending on amplitude and modulation of received signals, and the availability of storage facilities for incoming messages and messages to be transmitted. With both transmitters on the air, a suitable meteor trail could be detected and located within a few milliseconds. When a station heard a signal reflected by a meteor trail, it automatically shifted transmitting frequency. When both stations had shifted, messages were transmitted. At the end of a meteor burst, signal fading or obvious error in received messages caused the system to stop transmitting, and the transmitters returned to their original frequency.

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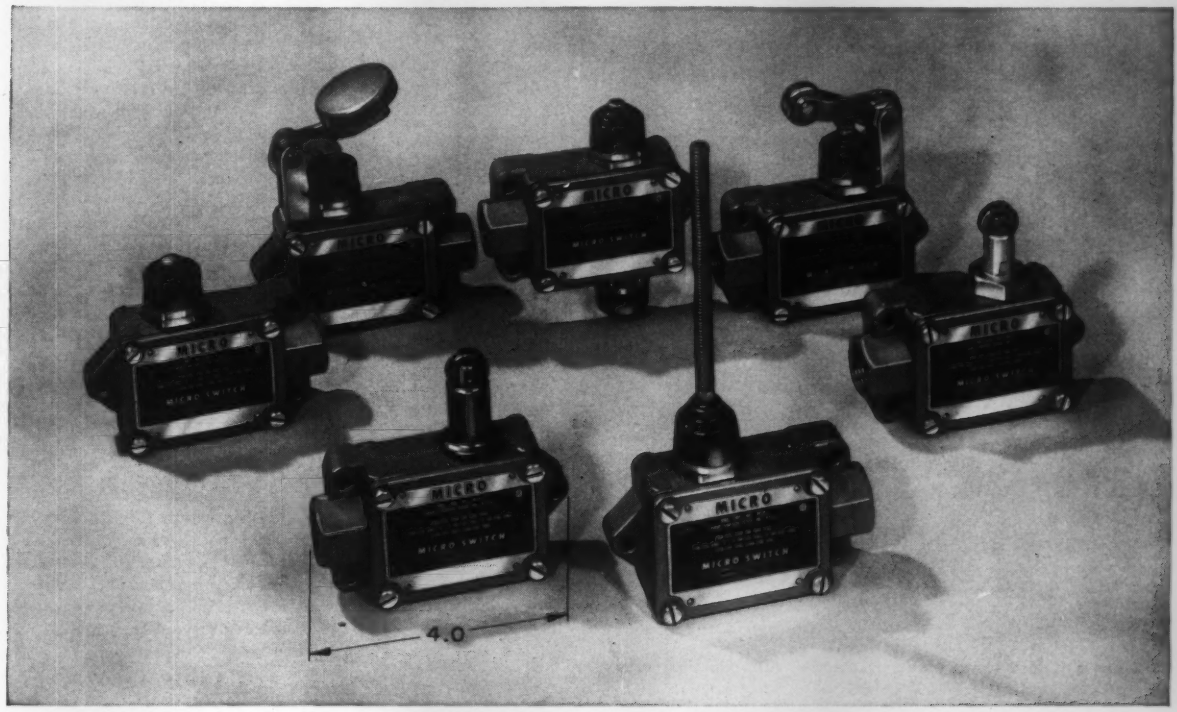
MICRO SWITCH Precision Switches



These high-capacity "BAF1" switches seal out dust, oil, and moisture

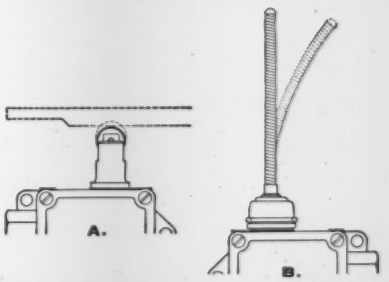
MICRO SWITCH "BAF1" enclosed switches are protected from physical damage by sturdy aluminum cases, and from oil, dust, dirt, and water by an O-ring seal between the case and the cover plate, and an elastomer boot around the plunger. Mounting holes accept ¼-inch bolts.

These high-capacity switches make and break steady state currents of 20 amperes and switch inrush currents as high as 75 amperes. The "BAF1" Series is especially suitable for heavy-duty industrial applications.

"BAF1" switches have single-pole double-throw contact arrangements. The switches may be used either normally-open or normally-closed. Available in either left hand or right hand mounting designs.

Consult the Yellow Pages for the name of the distributor near you. Send for Catalog 83.

Underwriter's Laboratories listing: 20 amps, 125, 250, or 460 vac; ½ amp, 125 vdc; ¼ amp, 250 vdc; 1 hp, 115 vac; 2 hp, 230 vac; 10 amps, 125 volts when controlling tungsten filament lamp loads on a-c circuits.



Sealed roller plunger actuator (A) can be adjusted horizontally through 360° permitting operation from any direction. Actuator shaft is protected by internal O-ring seal. Flexible coil spring actuator (B) can be operated from any angle except direct pull.

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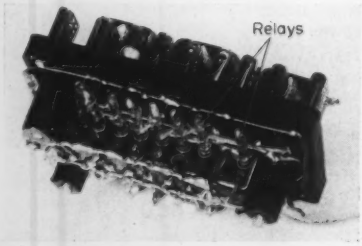
MICRO SWITCH Precision Switches

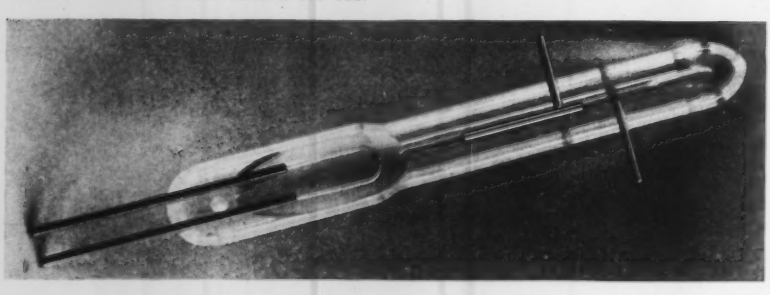
Copper-Bearing Frit Makes Durable Printed Circuit

Here's a simple way to make a strong ceramic-base printed circuit: Screen the circuit pattern onto the "card" using a ceramic paste that is 95 per cent copper oxide and 5 per cent bonding material. One firing at 750 C in air burns off the printing vehicle. A second firing at 850 C in a controlled atmosphere reduces the copper oxide to highly conductive copper. Developer, Bell Telephone Laboratories, New York, reports this test: Wires are attached to the pattern with a contact area of 0.01 sq in. At 2000 psi tensile stress, the ceramic generally breaks out before the bond fails. Atmosphere of reducing oven has hydrogen to reduce copper oxide and oxygen to prevent reduction of bonding fit. Ratio used is not explosive, says Bell. Low percentage of bonding frit gives film resistivity of 0.0015 ohm per square.

Gas Moves Mercury in Subminiature Relay

Sealed-in heating filament, when energized, expands highly compressed nitrogen in the oval chamber and drives a mercury column across the ends of platinum contacts to close a primary circuit. Relay is independent of ambient temperature changes and withstands vibrations of 100 g. Manufacturer, Telefunken GmbH, Ulm/Donau, Germany, claims maximum switch-on or switch-off time is 0.5 sec.





Topics

Bugs in machinery, the subject of many poor jokes, finally showed up in the flesh. A vertical-current meter was plagued by spiders which set up housekeeping in the pick-up mechanism. Presence of the webs resulted in incorrect operation of the meter, and measures taken to keep the device web-free were not completely successful. Proving man's superiority over a creature with twice as many arms and legs, resolute designers reworked the pick-up device. Now some of the parts rotate, and the rotating action tears the webs apart as fast as the spiders build them.

• • •

All the refrigerators in Russia are designed by 12 engineers. This startling fact was brought home from Moscow by Elisha Gray III, chairman of the board of Whirlpool Corp., where 150 refrigeration engineers are employed to design 15 models. Mr. Gray also noted that a Russian's "choice" of refrigerators is limited to white, 6 cu ft models and that there is a waiting period of over a year after an order has been accepted and qualified.

• • •

Fewer squawks from PA systems are promised by a new circuit developed by Bell Telephone Laboratories. Frequency of the signal from the microphone is lowered about five cycles before being fed to the loudspeaker. Feedback buildup is thereby eliminated.

• • •

Air Force eyes eels as possible inspiration for a new type of warning system. Electrical perception ability of the electric eel and the tropical knife fish lets them detect and identify objects by the various distortions in the electric field they set up in the water about themselves. The fish and eels are sensitive to differences in electrical resistance and conductivity. This sensory system has important implications, according to an Air Force spokesman, for design of electronic computers, electronic controls, and warning systems.

• • •

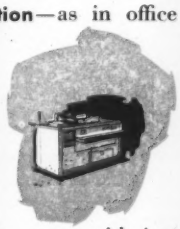
Putting the kart before the housework, a number of suburban homemakers have fallen prey to the new craze of racing tiny cars. These vehicles—karts—consist of a single bucket seat welded to a tubular steel frame; they ride on small pneumatic tires and are powered by lawnmower engines. Evolved from a daddy-made child's plaything, the kart has caught the fancy of adults as well, and about 300 manufacturers are producing models, some worth hundreds of dollars.

...and where can you use it profitably?

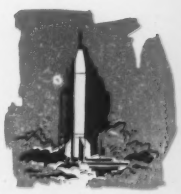
High-offset makes a difference!

It's the difference that lets you combine *high-reduction* with strength, compactness and other advantages you might find profitable in certain applications. For instance . . .

For smooth operation—as in office equipment that must run quietly—high-offset pairs provide smooth, quiet tooth action. Because the teeth "wrap around" the pinion, *you get continuous action—even with just one or two teeth.*

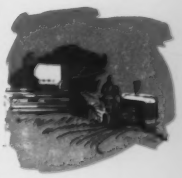


Where space is a problem—as in instrumentation—the high-offset lets you design a more compact unit. Choose just the offset to solve your design problem with a more flexible, more compact unit than the corresponding worm and wheel.



Where you need strength—as in farm machinery—high-offset hypoid pinions with teeth, which tend to "wrap around," are larger and stronger than corresponding bevel pinions.

High-offset or high-ratio hypoids can be cut on the same Gleason equipment that is used on more familiar spiral bevel and hypoid gears. You can also use the same testers, quenching presses and other auxiliary Gleason equipment you're using now. Grinders are available for applications requiring precision finish. For ratios of 1:10 or 1:40 or even higher.



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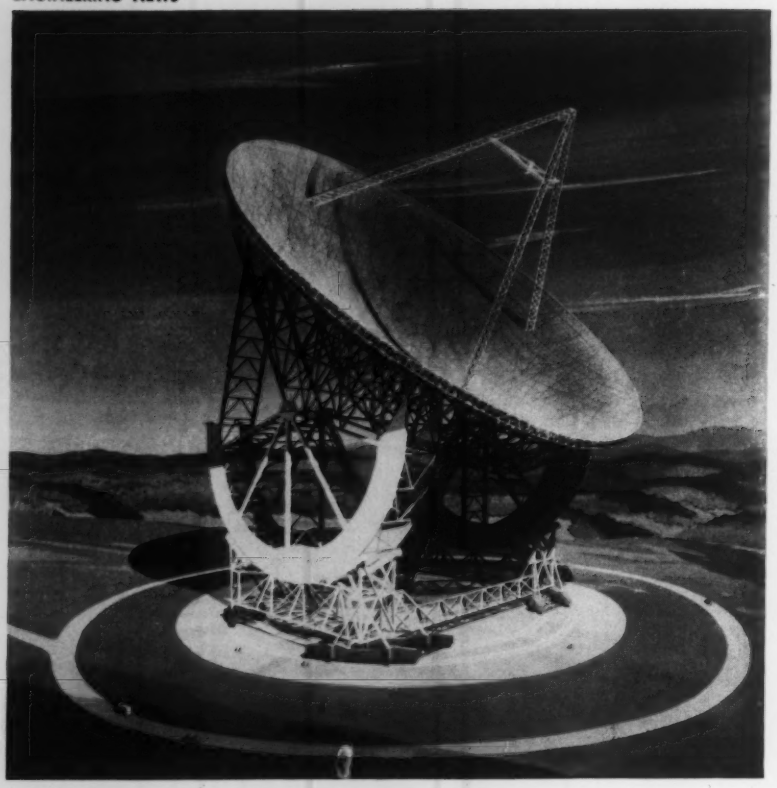


Giant Receiver Reads Remote Stars

Measuring more than 1/10 mile in diameter, this giant radio telescope will collect and focus radio signals from stars as far as 38 billion light years away. Specs were developed by Naval Research Laboratory; hardware is being designed for the Navy by Grad, Urbahn, & Seelye, New York. The 20,000-ton facility will be erected in Sugar Grove, Va., in 1962. World's largest radio telescope reflector now operating at Jodrell Bank, England, has a diameter of 250 ft.

Thin Films Will Raise Demineralizer Efficiency

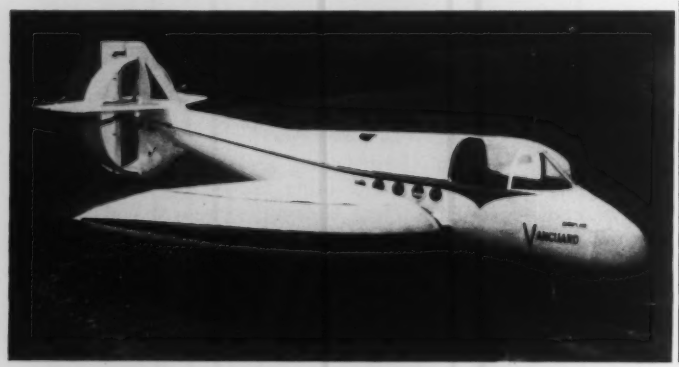
Evaporator, Condenser Films Improve Heat Transfer

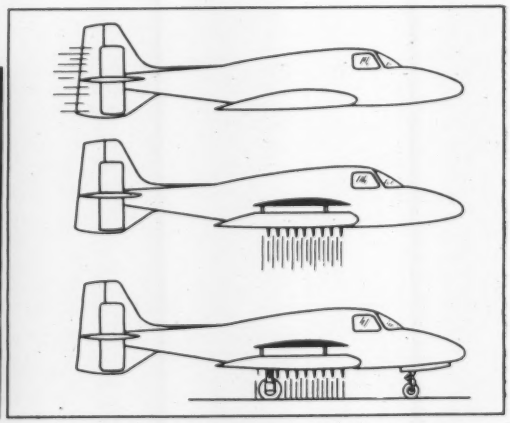
BURLINGTON, VT.—New equipment for changing salt water to fresh water is based on a little-used heat transfer concept. Heat-flow resistance is cut drastically by the use of thin films of water in both evaporation and condensation stages. Overall heat-transfer coefficients as high as 8000 Btu/hr/sq ft/F were obtained under laboratory conditions with the apparatus.

The General Electric Co. development uses a concentric vertical-tube distillation unit. A thin film of water for evaporation is achieved by spreading the fluid on the inner surface of the tube by means of a slowly rotating wiper. After heating, the pure water vapor is condensed on the outer surface of the tube where a thin film is developed by surface-tension techniques.

G. E. is now building prototype test models to prove the demineralization equipment. The final design is expected to provide lower energy consumption and thereby to reduce operating costs as compared to contemporary equipment. Lower initial cost and less maintenance will probably also result.

Fan-Wing VTOL Ready for Test





Radical new VTOL having lifting rotors within the wings is now ready for wind-tunnel and ground test. Designed by Vanguard Air and Marine Corp., Paoli, Pa., the plane obtains vertical lift from ducted rotors when cover plates on top of each wing are raised by hydraulic actuators and spring-loaded louvers are opened on wing bottoms. Forward speed is obtained by a pusher propeller in the tail. As speed increases after the takeoff, blade pitch of the rotors is decreased until the aircraft is traveling 50 mph. Rotors are then declutched and cover plates and louvers closed. The aircraft is designed to hover, take off and land vertically, and reportedly can be designed to travel at forward speeds of more than 350 mph. Both military and civilian applications for the craft are claimed.

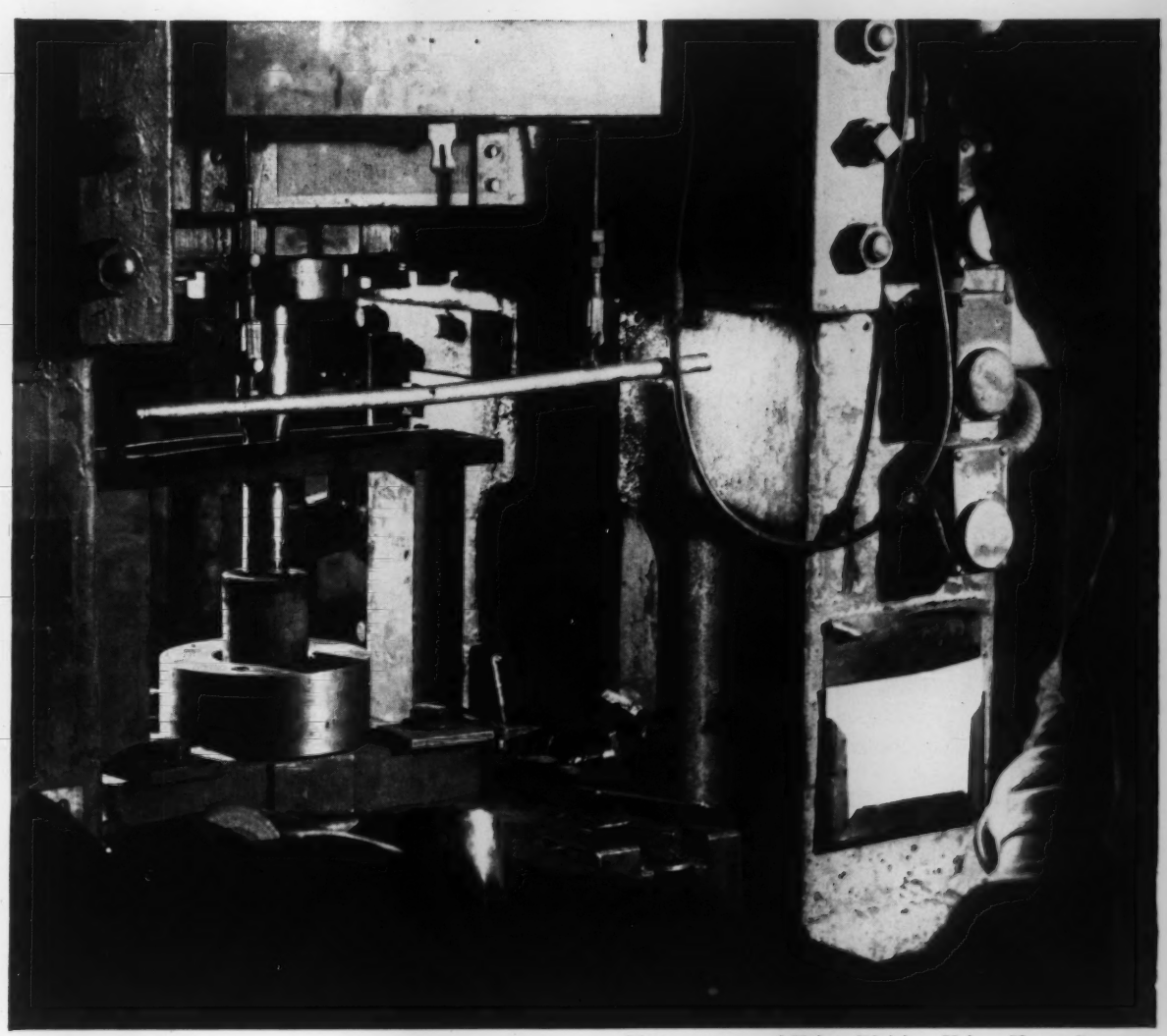


Photo courtesy of Heintz Division, Kelsey Hayes Company

HIGH PRODUCTION cold extruding proof of Aristoloy uniform quality

High-speed production of cold extruded parts like this track link bushing for a midwest equipment manufacturer can not tolerate variations in quality. Physical and chemical uniformity are all-important if costs are to be kept in line and rejects eliminated.

Aristoloy 8620 electric furnace steel meets the high quality requirements of Heintz Division of Kelsey Hayes Company and its customers.

From the melt shop to rolling and finishing operations, careful control guarantees that delivered bars will meet the most rigid standards of quality.

For complete information about Aristoloy leaded or standard carbon, alloy and stainless grades, call the Copperweld representative in your nearest large city. Or write today for NEW PRODUCTS & FACILITIES CATALOG.

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COPPERWELD STEEL COMPANY

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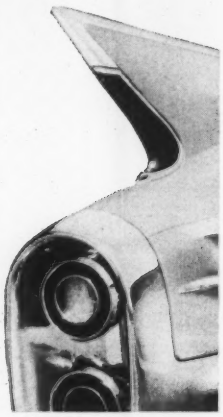
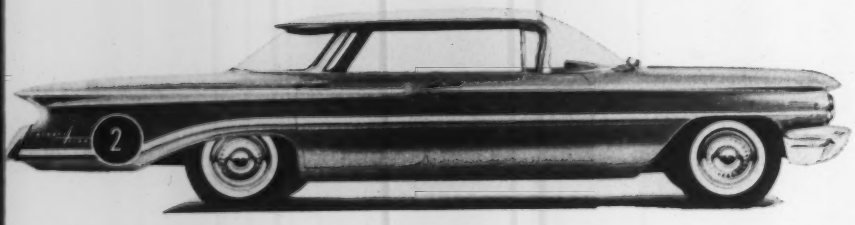
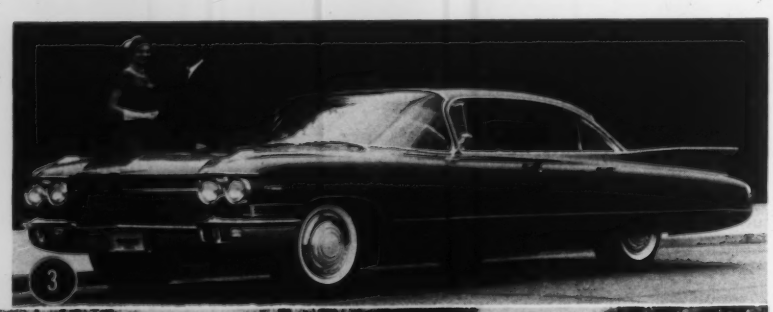
the '60s take the road





1. PONTIAC
2. OLDSMOBILE
3. CADILLAC
4. CHEVROLET
5. BUICK

The average American's choice of an automobile, as opposed to his outspoken opinion of what a car should be, continues to bug many experts in the business. Automakers have long known that styling features can sell more cars than a major engineering innovation. Chrome and fins, of course, are the result. But last year, with the rise of the compact car, some experts thought they detected a ray of practicality. Buick, for example, almost bereft of ornamentation in '59, was initially the envy of most other GM divisional staffs. In their opinion, the car's clean lines retained plenty of style. But Buick's cousins with flashier chrome ran off with sales honors. So this year, back in the family, Buick can show off some shiny new trim. And this is pretty much the trend throughout the industry—an emphasis on styling in the big-car lines, with the small cars making news from an engineering standpoint.



The brief rundown of GM cars in this issue, including Corvair (page 24), describes what is new this year, mechanically. Chrysler, Ford, and the independents will be covered in a subsequent issue.

Cadillac

A revamped braking system is the most significant mechanical change on GM's top car. The system includes self-adjusting brakes, new for

Torrington Needle Bearings are available for shafts up to 7¼" in diameter. Full complement of rollers provides highest radial capacity for a given cross section. They offer low unit cost, compactness and light weight and long service life. They take a press fit in a simple straight-bore housing, run directly on hardened shafts, permitting use of larger and stiffer shafts.

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You have everything to gain by applying a large diameter Torrington Needle Bearing in your heavy duty applications.

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These advantages have been proved in performance in tractor bolsters, transmissions and final drives. In haybaler crank shafts. In power shovels. In heavy duty hydraulic pumps and starting motors. In road wheel arms on tanks. Why not talk over *your* application with your Torrington representative? **The Torrington Company, Torrington, Conn.—and South Bend 21, Ind.**

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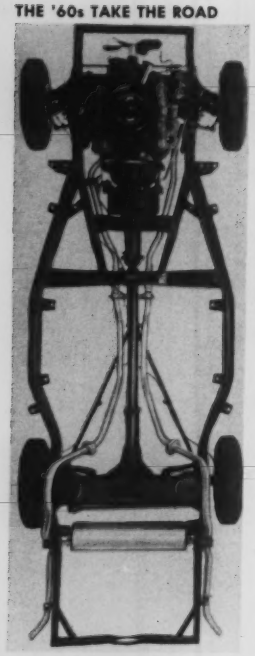


'60 Engines

Make and Model	Bore & Stroke (in.)	Displacement (cu in.)	Compression Ratio	Power, max (bhp)	Torque, max (lb-ft)	Carburetion
CADILLAC						
Series 60, 62, 75	4.00 x 3.87	390	10.5:1	325 @ 4800	430 @ 3100	4b
Eldorado	4.00 x 3.87	390	10.5:1	345 @ 4800	435 @ 3400	4b
BUICK						
LeSabre (standard)	4.12 x 3.40	364	10.25:1	250 @ 4400	384 @ 2400	2b
(optional)	4.12 x 3.40	364	9:1	235 @ 4400	375 @ 2400	2b
Invicta, Electra	4.19 x 3.64	401	10.25:1	325 @ 4400	445 @ 2800	4b
OLDSMOBILE						
88	4.00 x 3.69	371	8.75:1	240 @ 4400	375 @ 2400	2b
Super 88, 98	4.12 x 3.69	394	9.75:1	315 @ 4600	435 @ 2800	4b
PONTIAC						
Catalina, Ventura, and Star Chief	4.06 x 3.75	389	8.6:1	215 @ 3600	390 @ 2000	2b
Bonneville	4.06 x 3.75	389	8.6:1	281 @ 4400	407 @ 2800	4b
Optional	4.06 x 3.75	389	10.25:1	283 @ 4400	413 @ 2800	2b
			10.25:1	303 @ 4600	425 @ 2800	4b
			10.75:1	318 @ 4600	430 @ 3200	Three 2b
CHEVROLET						
V-8 Options	3.87 x 3.00	283	8.5:1	170 @ 4200	275 @ 2200	2b
			9.5:1	230 @ 4800	300 @ 3000	4b
	4.12 x 3.25	348	9.5:1	250 @ 4400	355 @ 2800	4b
			9.5:1	280 @ 4800	355 @ 3200	Three 2b
			11:1	305 @ 5600	350 @ 3600	4b
			11.25:1	320 @ 5600	358 @ 3600	4b
			11.25:1	335 @ 5800	362 @ 3600	Three 2b
Six Cylinder	3.56 x 3.94	235.5	8.25:1	135 @ 4000	217 @ 2000	

'60 Sizes

Make and Model*	Wheelbase (in.)	Length (in.)	Width (in.)	Height† (in.)
CADILLAC	130	225	79.9	56.2
BUICK				
LeSabre	123	217.9	80	57.2
Invicta, Electra	126.3	221.2	80	57.5
OLDSMOBILE				
"88"	123	217.6	80.6	56.1
"98"	126.3	220.9	80.6	56.1
PONTIAC				
Catalina, Ventura and Star Chief	122	213.7	80.7	56.6
Bonneville	124	220.7	80.7	56.6
CHEVROLET	119	210.8	80.8	56

*Four-door sedan. †With full design load.

Buick's Muffler: No more cold spots

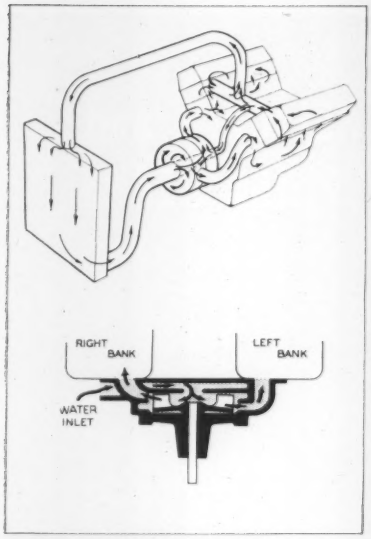
Cadillac, and a vacuum-released parking brake, new in the industry. The parking brake releases automatically when the car is put in gear and can be used as a true foot-operated emergency brake. Cadillac's self-adjusting brakes, like others now in use, align when the car is braked in reverse. Rear drums are finned this year, reducing braking temperatures under high-speed driving conditions. Engine and body specifications are unchanged.

Buick

Buick's brakes have also been refined this year. Wheels and wheel covers are slotted to increase and accelerate air-flow over the drums. This culminates a major two-year effort by Buick (aluminum fins in front last year) to perfect a relatively fade-free system. Other functional changes include a unique muffler, placed crosswise of the frame behind the rear axle, which replaces the multiple-muffler system commonly used. The transverse unit has an inlet and outlet at each end, permitting gases from each bank of cylinders to enter a common chamber after passing through individual resonating chambers. This not only saves space, but increases muffler life because the usual "cold side" is eliminated; this, in turn, minimizes corrosive condensate. Buick's engine and body specifications are almost the same as last year's except that an optional engine, tailored to burn regular-grade gas, is offered in LeSabre.

Oldsmobile

Minor mechanical changes are also reported by Oldsmobile. Rear axle ratios have been lowered on all models, nylon-skirted pistons are new in shock absorbers, and a slimmer Hydra-Matic reduces the transmission hump in front by 1 in. in height and about 2 in. in width. Fluid capacity of Hydra-Matic has been cut 2 qt in the process. Modifications of the "88" engine have been made in the interest of economy. Power rating is down from



Pontiac's Water Pump: No more hot spots

270 to 240 hp, and the engine is designed to burn regular fuel.

Pontiac

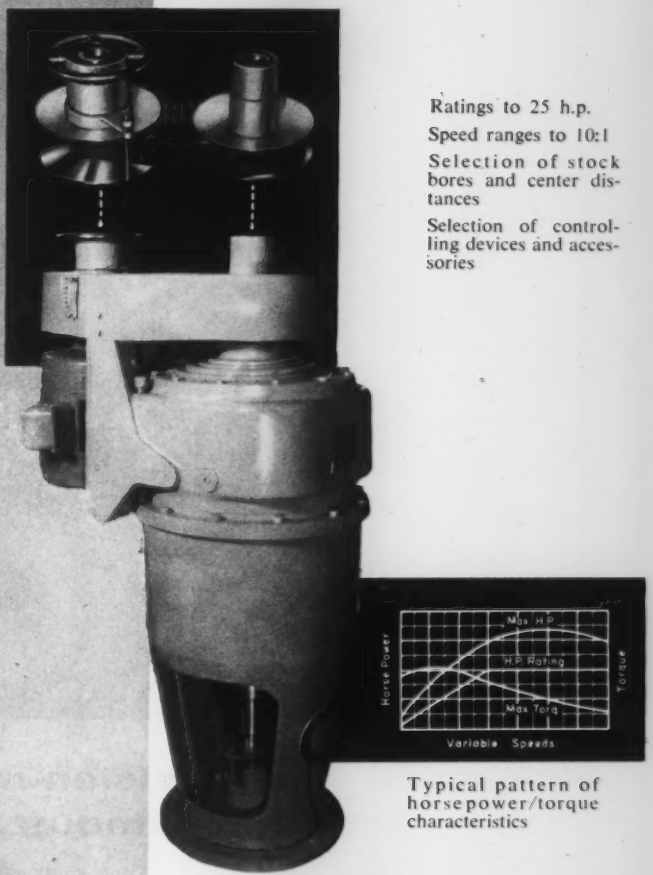
Pontiac again features one of the most versatile engines in the industry. Compression ratios range from 8.6:1 to 10.75:1; power ratings from 215 to 318 hp. The engine cooling system has been redesigned this year to use a new divided-chamber water pump which assures equal flow of water to each cylinder head. Like Oldsmobile, Pontiac uses newly designed shock absorbers with nylon-sleeved pistons, and also gets a noticeable reduction in transmission hump by using GM's new slim Hydra-Matic.

Chevrolet

Following the example set by other GM cars, Chevrolet's big change this year is in appearance. Engine modifications represent the major engineering changes. Chevy's traditionally wide selection of powerplants include two with compression ratios of 11.25:1—probably the highest in the industry. Since members of GM's research staff have recently quoted the feasibility of 12:1 engines, Chevy may get there ahead of the pack. At the other end of the scale, Chevrolet engineers have lopped 15 hp off the least powerful V-8 in their line—it's down from 185 to 170 hp in a move to satisfy the economy-bent buyer.

LEWELLEN

COMPONENTS INCORPORATE VARIABLE SPEEDS



Ratings to 25 h.p.

Speed ranges to 10:1

Selection of stock bores and center distances

Selection of controlling devices and accessories

Typical pattern of horsepower/torque characteristics

The shaft of a standard motor and the equipment input shaft mount the drive.

With an 1800 r.p.m. motor, any input speed from 500 to 4000 r.p.m. is available.

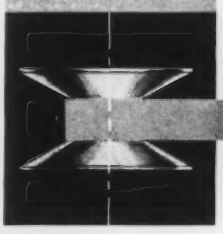
Handwheel adjusts speeds while running, without altering shaft center distance.

Shaft and bearing loads are normal. No thrust loads are imposed. No beefing or supporting structure is required.

Installation is quickly and easily made. Normal service requires only routine lubrication.

Sustained performance with overload capacity is obtained.

Lewellen Combination Pulleys offer a direct, compact, economical method for applying variable speeds.



Catalog 70 defines and dimensions the performance, convenience and utility of Lewellen Pulleys.

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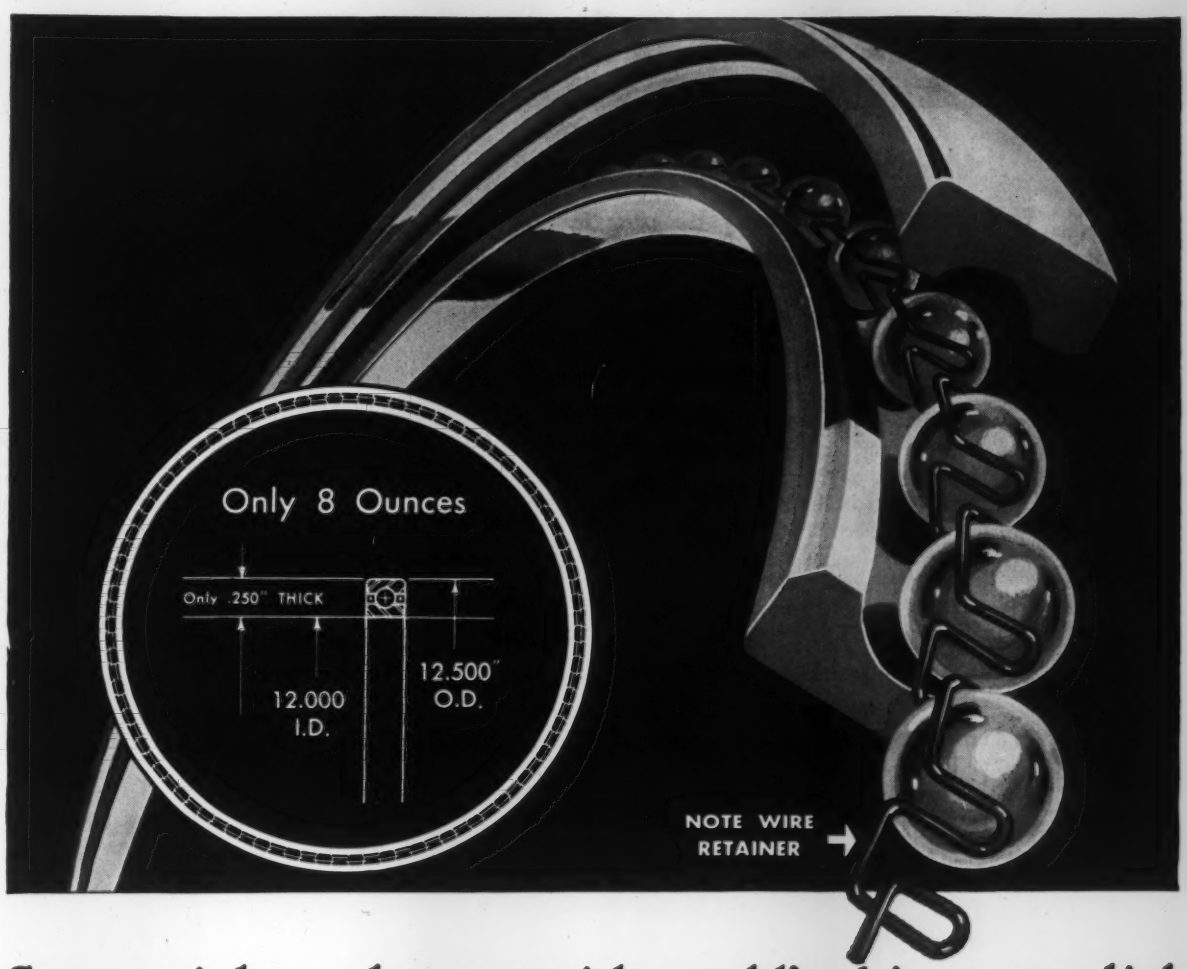


Save weight and space with world's thinnest radial ball bearings—*Reali-Slim* by Kaydon ...now carried in stock in 4" to 12" bores

HERE it is! A *Reali-Slim* radial ball bearing with a wire separator that has just short of a full complement of balls for maximum capacity. What's more, you still get all the advantages of a separator between the balls. This design also gives you a bearing that's light-in-weight and is, without a question, the thinnest bearing ever built in this diameter.

Whatever your product design, there's a small or large diameter *Reali-Slim* bearing that can be the right answer to your thin-section bearing problems.

The radial ball bearing, illustrated here, is *really slim* — 12.000" I.D., 12.500" O.D., .250" thick . . . *and weighs only eight ounces.* It has 9,810 lbs. static load capacity, 1,256 lbs. at 100 rpm. Kaydon is able to produce *Reali-Slim*, high-precision bearings because Kaydon specializes in the unusual.

Kaydon bearing engineers are prepared to give you valuable help with technical, thin-section bearing problems.

For detailed information on Kaydon's *Reali-Slim* line, ask for engineering catalog No. 54-RS3 detailing:

Reali-Slim Ball Bearings — Conrad, angular contact and 4-point contact types in seven standard cross sections from ¼" to 1.000" and in bore diameters from 4" to 40".

Reali-Slim Roller Bearings — Radial and taper roller types in cross sections from 9/16" and in bore diameters from 5" to 40".

THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

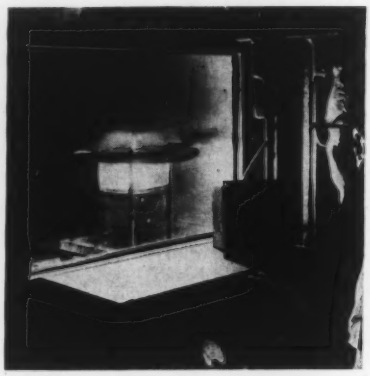
K-561R

All types of ball and roller bearings — 4" bore to 178" outside diameter . . .
Taper Roller • Roller Thrust • Roller Radial • Needle Roller • Ball Radial • Ball Thrust Bearings

Circle 413 on Page 19

future heatshields may be plastic

Organic plastic that can withstand 15,000 F—twice the sun's surface temperature—may be the heatshield material for future space vehicles. Simplicity of fabrication with the new plastic will cut the cost of making nose cones, says developer, General Electric Missile and Space Vehicle Department. After preparation, the material is simply poured into a mold. Properties of the plastic can be tailored to specific jobs—it can be elastic, flexible, or hard.



some came back

Pirating of engineers is still very much in evidence, as witnessed at the recent Western Electronic Show. One conference veteran estimated that 1000 of the 20,000 present were recruiters; another guessed that one third of the engineers attending were there to find new jobs. One up-and-coming company reportedly recruited more than 100 engineers, but lost three for each four it hired—net recruitment cost was almost $10,000 each. The harassed vice president of another major electronics firm complained that he not only lost engineers, but 60 per cent of his recruiting force was hired away.

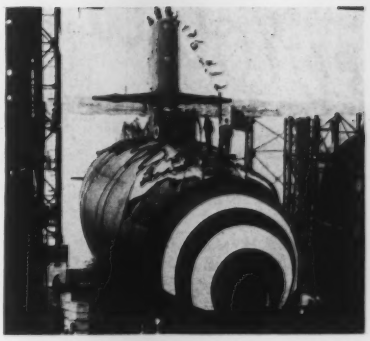
x-ray testing set for steel castings

X-ray standards for determining the strength of steel castings will be established for the Air Force by Convair Division, General Dynamics Corp. F. A. Monahan, manager of manufacturing development for Convair, said the project will be accomplished by inducing imperfections in a cast slab, x-raying test bars that contain the imperfections and then testing them to destruction. By comparing these x-rays and strength characteristics with those of a perfect slab of cast metal, the x-rays can be standardized. Monahan pointed out that until now there has been no substitute for destructive testing of castings. Standardized x-ray pictures developed under the program will be made available to industry as uniform tools in measuring the strength of cast steel without the need for physical testing. Convair has completed a similar program for aluminum and magnesium castings, and these standards are now in use.

heat seeker with a chill

A supercold refrigerator the size of a flashlight is the latest refinement in infrared target-detecting equipment. It chills the detector down to −350 F. At this temperature the equipment radiates little infrared, and can therefore sense a much weaker signal than previously. And because it can also respond to a wider range of wavelengths at low temperatures, it can detect smaller temperature differences between the target and the target's surroundings. The device was developed by Arthur D. Little Inc., Cambridge, Mass.

subs get built-in nervous system



New sonar system for submarines, said by the Navy to be one of the most comprehensive detection systems ever devised for underwater craft, combines sophisticated searching gear, electronic control of underwater firepower, and advanced communications techniques. The entire system will be an integral part of the hull design, a new concept in submarine construction. Developed by Raytheon Corp., the equipment is expected to add considerable flexibility to submarine tactics. Findings can be relayed to companion sub-killers for co-ordinated attack, and an attack can be made from a concealed underwater position, instead of surfacing to periscope height for visual sighting.

gears "flame hardened" in salt bath

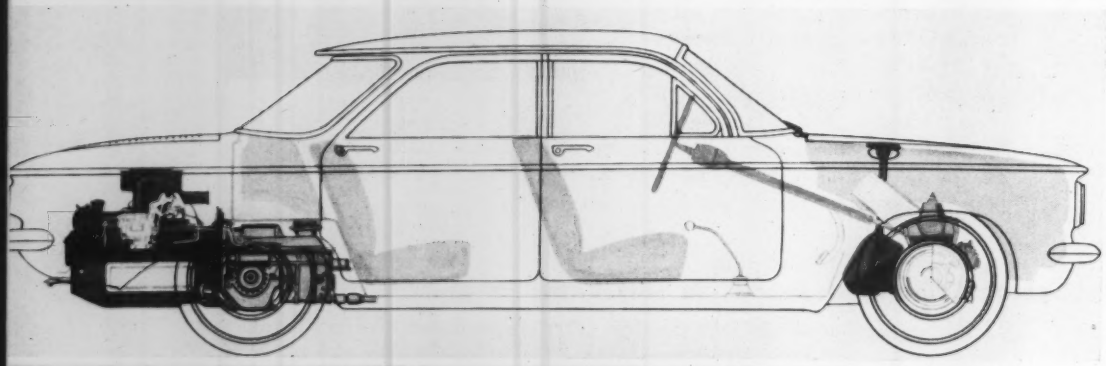
Uniformly hard teeth on distortion-free gears are produced by a new hardening process called liquid flame hardening. The process developed by Yale & Towne, Philadelphia, is superior to flame hardening in precision of hardening pattern, and to most other processes in economy. After carburization, gears are mounted on a mandrel, spun at 45 rpm, and lowered until just the teeth are immersed in a molten salt bath at 1750 F. Quenching is done by spinning the gears at a faster rate in a conventional quenching tank. Cyanide can be added to the neutral salt bath if required. Hardness on conventional steels can be closely specified up to RC 60.

answering service

Large-scale computer center slated for the Houston, Texas, area will be one of the first of a planned nation-wide series to service American industry by geographical location. Intended to handle the Southwest's computer needs, it will be equipped with the newest and largest computing equipment available. Staff will include mathematicians, programmers, economists, logistics analysts and other specialists. According to Dr. H. W. Robinson, president, C-E-I-R Inc., Washington (the company that will operate the center), the plan will give business and industry a better chance to take advantage of the coming generation of computers. The new machines are becoming so expensive that they must be kept continually busy on productive work, almost around the clock, before their huge cost can be recovered. Even at present, it is difficult for many of the largest corporations to keep one of the lightning-fast machines completely occupied on company problems.

Native Detroiter with a foreign accent:

Chevrolet's corvair



Falcon-Corvair Comparison

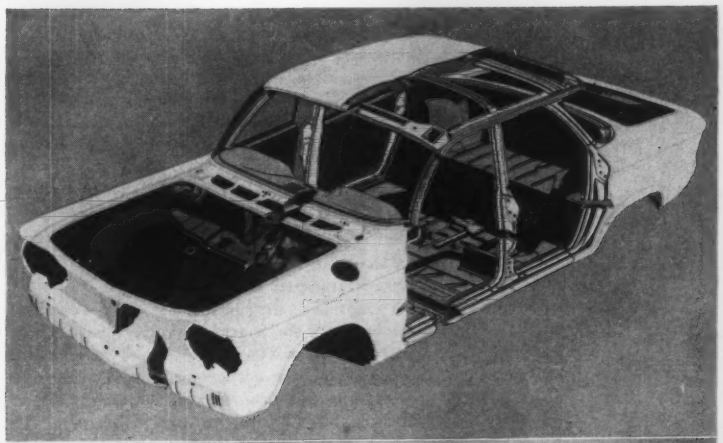
Specifications	Falcon	Corvair
Engine		
Type	Six-in-line, OHV	Six, horizontally opposed
Bore & stroke (in.)	3.5 x 2.5	3.37 x 2.60
Displacement (cu in.)	144.3	140
Compression ratio	8.7 to 1	8 to 1
Power, max (bhp)	90 @ 4200	80 @ 4400
Torque, max (lb-ft)	138 @ 2000	125 @ 2400
Body		
Weight (lb)	2366	2340
Wheelbase (in.)	109.5	108.0
Length (in.)	181.1	180.0
Width (in.)	70.0	66.9
Height (in.)	54.5	52.8

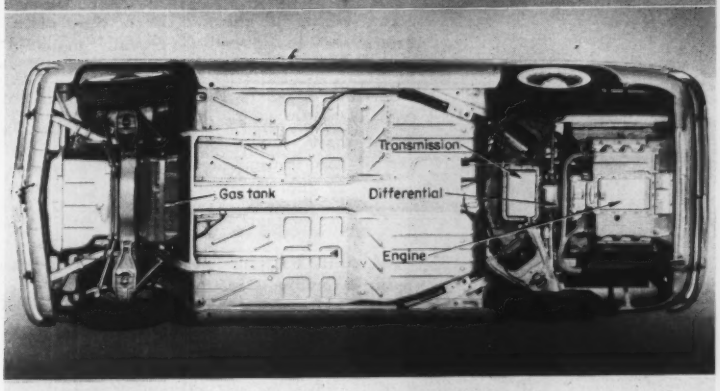
EVERY YEAR, Detroit's big three make "dramatic" changes in their annual products. Mostly evolutionary (and mostly restyling), these changes are always a result of "what the public demands." This year, Chevrolet initiates some engineering innovations, all wrapped up in the new compact Corvair.

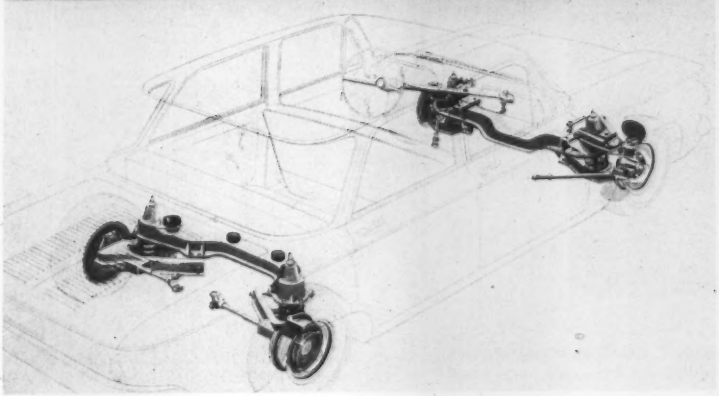
Like Ford's Falcon and Chrysler's Valiant, Corvair is designed to steer the public away from foreign imports. Whether or not it accomplishes this mission, it stands alone among U. S. cars in offering these significant design features:

- Horizontal, air cooled, six cylinder engine; rear mounted.
- Independent swing-type rear suspension.
- Integral transmission-axle assembly (transaxle).

As unique as these features are in an American car, Chevrolet is







Body and Suspension

Corvair's unitized body weighs 60 per cent less than a separate-frame structure and, according to GM, is about 30 per cent more rigid, torsionally. Driveline tunnel is practically extinct, although a slight hump is still needed for rigidity and to form a protected area for engine and transmission controls.

Swing-type independent rear suspension is new for U. S. cars, but a familiar item on imports (Mercedes; Volkswagen). Differential and final-drive gear case are mounted to the sprung mass of the car; axle shafts are individually driven through U-joints on each side of the differential. Suspension travel is provided by allowing the wheels to swing through arcs of a radius equal to the axle-shaft length. Rugged box-section control arms support the wheel bearings, brake backing plates, and react against the suspension coil springs and shock absorbers. Control arms are mounted in a semi-trailing attitude so that their projected pivot axes pass through their respective axle shaft universal joint centers. In this manner, angular deviations between the control arms and axle shafts are held to a minimum.

Because the rear wheels are independently suspended, new geometry factors appear: Toe-in, for example, is designed to increase positively as the suspension moves up or down from the design-height position. Since the outside wheels carry the greatest weight in turns, the toeing-in characteristics of the rear suspension create a desirable understeer geometry. This is important when the greater share of the weight is carried by the rear wheels (oversteering would be the normal tendency).

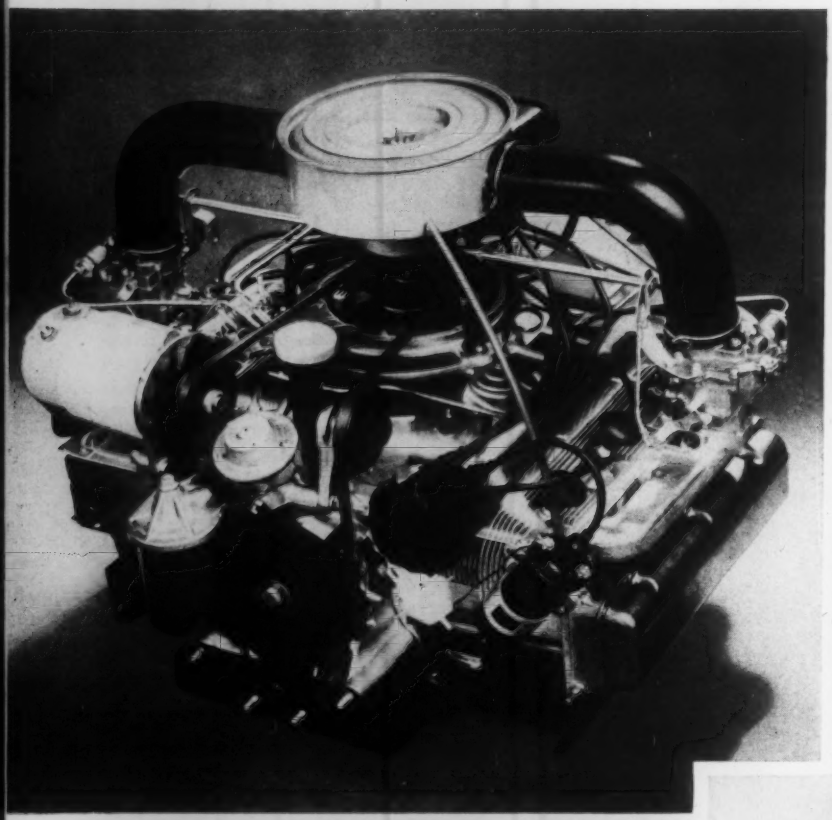
To adjust the basic toe-in setting in production or service, transmission mounts in front and engine mounts in the rear can be shimmed to move the entire engine-differential-transmission assembly fore or aft. This adjustment similarly moves the axle shaft inner ends, giving proper straight-ahead alignment at design weight.

hedging against buyers who want a little bit more. A deluxe Corvair, called the "700," will sport additional outside trim and plushier interior treatment. Optional items on all models include automatic transmission, folding rear seat, and gasoline heater.

Since major American car-builders are already engaged in much friendly controversy regarding engine location, here, for the record, are the facts that prompted Chevy to approach the problem from the rear:

Typical weight distribution in an average front-engine car is 55 per cent on front wheels, 45 per cent on rear wheels. The usual passenger placement distributes about ¼ of the car's "payload" on the front wheels, ¾ on the rear. Since weight of the vehicle is usually so much greater than its payload, the shift in c.g. toward the rear does not become serious.

In a small, lightweight car, however, the c.g. shift could bring about a drastic modification in handling and ride. For example, a compact car with a forward power train might start with 55 per cent of its weight on the front wheels when empty, shift c.g. to put 55 per cent on the rear wheels when fully loaded. Load on the rear springs would increase as much as 66 per cent, so if rear springs were designed to deflect 5 in. under full load, they would have only 3 in. deflection when light. This obviously would not provide American-



Power Train

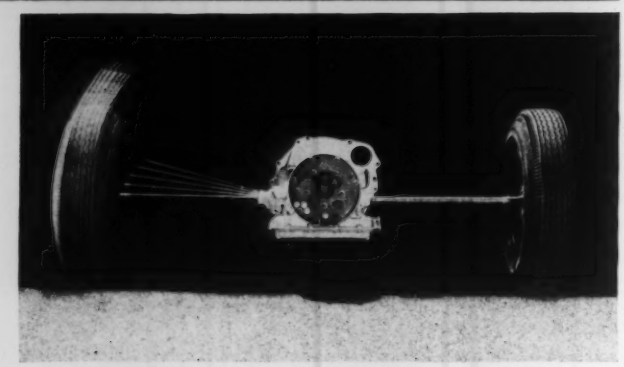
Because it's air cooled, Corvair's engine has no conventional cylinder block. Central structural member is the aluminum-alloy crankcase, rectangular in shape and cast in two halves. Each trio of individual cast-iron cylinders is held in place by a cast-aluminum cylinder head. Flat-headed pistons are cast-aluminum alloy, with two compression rings and one single-piece oil control ring.

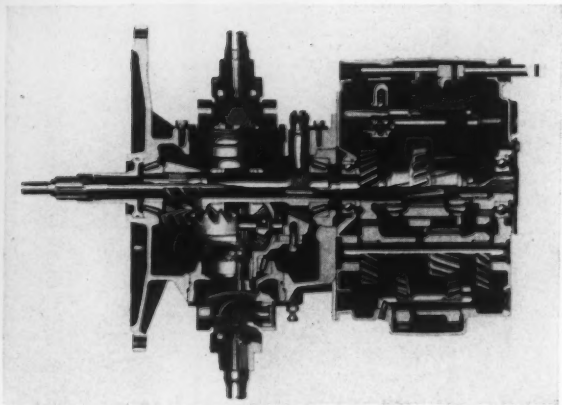
Valves (in-head) are actuated by push rods through stamped rocker arms—like Chevrolet V-8 engines. The camshaft is unconventional —it has only three exhaust-valve lobes. These are twice the width of the intake-valve cams, so that each lobe actuates a pair of push rods. Lubricating oil drains from cylinder heads to oil pan through the push-rod tubes.

The engine is enclosed in a sheet-metal shroud and cooled by a vertically mounted centrifugal blower.

Corvair's standard three-speed transmission mounts directly to the differential. Input and output shafts extend concentrically from the rear of the transmission case. Transmission gearing is the same as that in Chevrolet, except that ratios are changed to give Corvair a 1:1 ratio in third (no gears).

The entire transmission-axle (transaxle) and engine assembly is mounted in the chassis as a single unit, with transmission forward.





type riding qualities. Also, if the car were braked while lightly loaded, rear springs and axle would unload still further, almost canceling out the effectiveness of the rear brakes.

In the Corvair, static weight distribution (no acceleration) is 40 per cent front, 60 per cent rear. Since braking tends to shift weight to the front wheels, weight transfer becomes an advantage. (Chevrolet points out that the existing balance of loaded station wagons is about 40/60.)

Chevy engineers also believe that it is desirable to calibrate braking distribution so that rear wheels will slide first in the event of a panic stop—a sliding wheel can sustain no side force, and with only the rear wheels sliding, the car can still be directionally controlled by the front wheels. Distribution of braking effort on the Corvair is 54 per cent to the rear wheels, 46 per cent to the front. This is done by using $\frac{7}{8}$-in. diameter wheel cylinders in front, 15/16-in. diameter at rear. Since most braking is not at maximum rates, brake-lining area is evenly divided front and rear.

To give Corvair precise handling characteristics, Chevy engineers considered two other factors: 1. Rear tires should not be overloaded, or the car will tend to wander. 2. Sense of direction of rear wheels should be slightly better than front wheels, to give the desired amount of understeer.

The first factor is handled in a conventional manner: Low-profile tires (6:50 x 13) mounted on wide rims. Reduced inflation in the front tires takes care of the second factor (15 psi, front; 26 psi, rear).

Milling the Ultrametals

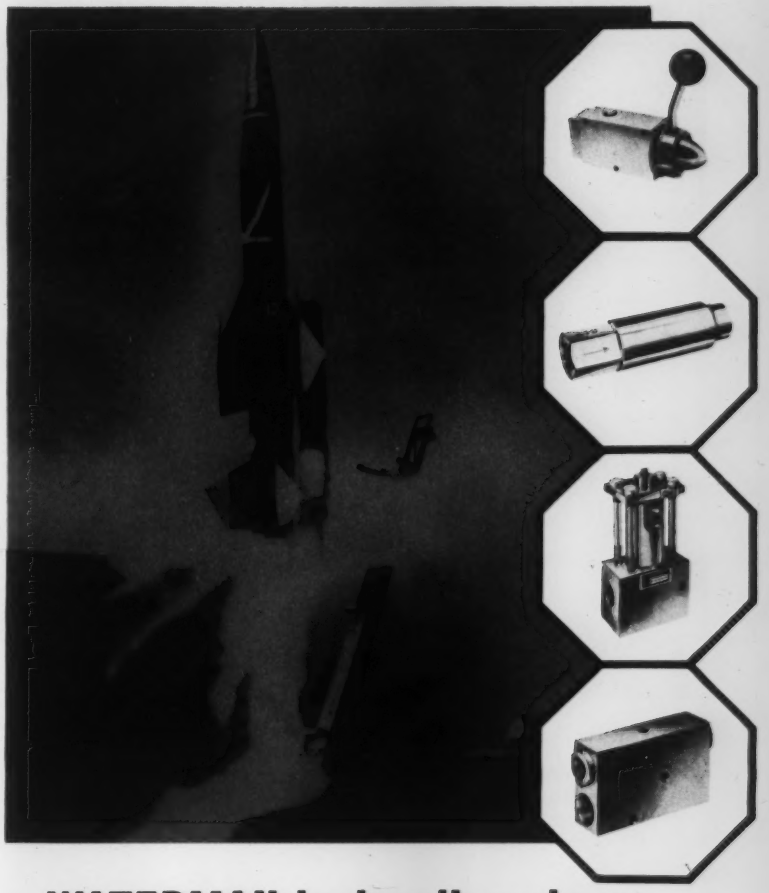
Machining the ultrahard, heat-resistant metals may become cheaper. A new milling process developed by Boeing Airplane Co., Seattle, combines high speeds of routing with mechanical feeds, cutting pressures and solid fixturing of standard milling practice. It uses carbide-brazed cutting tools and liquid carbon dioxide cooling on both cutter and point of machining. Cutter speeds as high as 7000 rpm and feed rates up to 180 ipm can be achieved with long life for tools.

Thinking Computers Not Yet on the Horizon

ANN ARBOR, MICH.—Even though present computers can store a billion bits of information, they are still "enormously stupid." The modern-day computer "is really nothing more than a set of switches—an abacus gone mad with size and speed." So said Leonard Uhr, research psychologist, University of Michigan, at a meeting of the American Psychological Association.

A decade ago, he noted, the computer was an interesting—but hopelessly oversimplified—analogy to the human brain. While today it works like the mind in some respects, much still remains to be done. "Probably the most interesting work at the moment is going on in cognition—in theorem-proving, problem-solving, and game-playing machines." The field of greatest importance is probably that of learning.

Although a great amount of work has been done in theory and design of perceiving machines, little use has been made of this research. The human mind is a perceiver that far surpasses any proposed machine, and is a living demonstration of what can be done. "It seems especially promising to design machines as humans appear to be designed."



WATERMAN hydraulic valves spell RELIABILITY at low cost for ground support equipment

The remarkable adaptability and performance of these and other Waterman *standard* hydraulic components has earned them a front-line place in the support equipment for America's most reliable missiles.

In the Waterman line, you can select from the widest choice of fixed-flow and full-range adjustable flow regulators . . . with precisely controlled flow rates up to 100 g.p.m. and a choice of adjusting devices. Solenoid valves, both A.C. and D.C., that feature tight shut-off, full line flow at low pressure drop, and the fast, positive action that this kind of service demands. Counterbalance valves that employ a unique Waterman principle for positive control of negative loads. Plus many other types. All rated at 3000 p.s.i. Special designs to meet unusual needs.

Design your hydraulic systems arcund *proved* Waterman valves and controls! Save time—save money—and be *right . . . from the start!*

Waterman representatives are in all principal cities. Write for Waterman Flow Regulator Catalog No. 1001; Solenoid Valve Catalog No. 2001; Catalog on filters and miscellaneous valves, No. 3000.

Also suppliers of AN and MS qualified flow regulators and fuses.

WATERMAN ENGINEERING COMPANY

W-5925

WATERMAN ENGINEERING COMPANY • 725 Custer Ave., Evanston, Ill.

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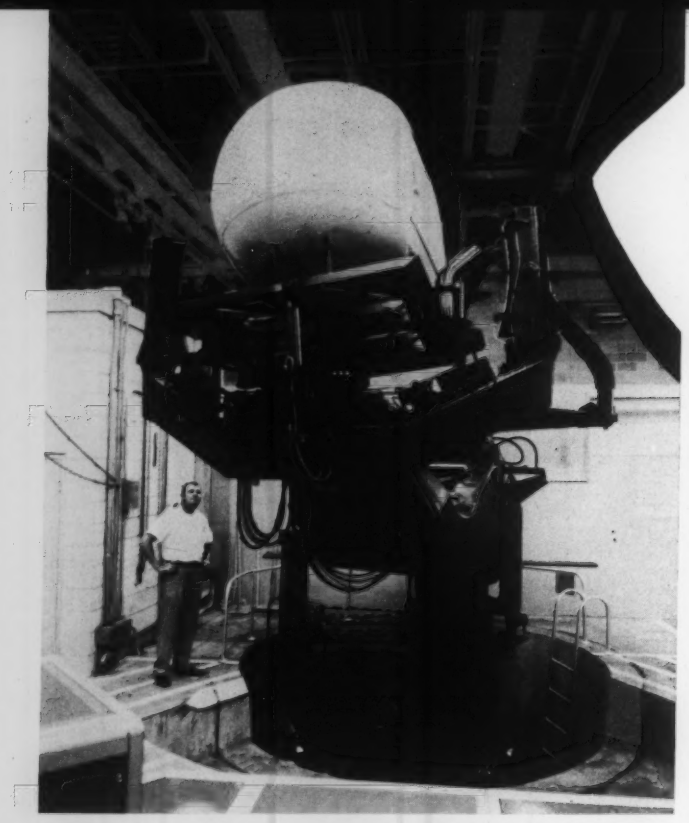


Helicopter flight simulator was developed by Franklin Institute for Bell Helicopter Corp. It permits close study of pilots flying with new blind-flight instruments and controls. A computer accepts control movements, calculates the response of the simulated helicopter, and instructs the moving platform. A display generator driven by the computer presents visual information about altitude, attitude, and velocity to the simulator's "pilot".

Tomorrow's aircraft to have simple cockpit

Pictures Will Replace Dials and Gages

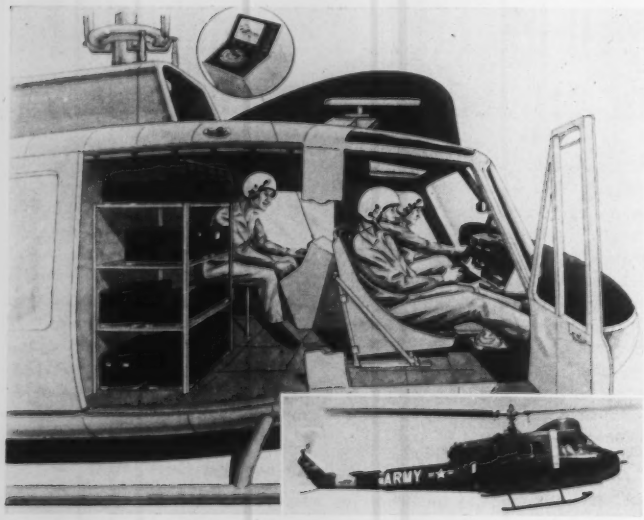
DALLAS—Latest thinking about all-weather eyes for aircraft—ranging from helicopters to re-entry vehicles launched from a satellite—calls for simplicity. Man-machine relationships are changing, and more and more emphasis is being placed on decision making by the machine half of the team.

The sophisticated cockpit of tomorrow's aircraft will have fewer dials, needles, gages, and other instruments requiring the pilot's interpretation. Instead, data will be displayed pictorially. Experimental models of such human-engineered cockpits were unveiled last month at the ANIP Symposium in Dallas.

As a part of this progress report on the Army-Navy Instrumentation Program, several new data display systems, research instruments, and instrumentation advances were announced and/or displayed:

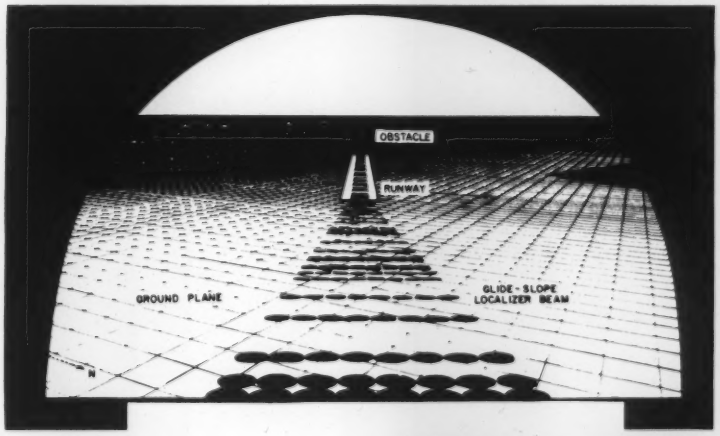
- Helicopter flight simulator that reproduces sounds, motions, vibrations, and general cockpit arrangement of most helicopters.
- Two research helicopters—actually flying laboratories — used for flight evaluation of new instruments.
- Flight data display systems that present electronic, computer-constructed pictures of outside conditions during bad weather or night flying.
- Components for airborne instruments, computers, microcircuits, and new concepts in equipment.

Need for ANIP is best demonstrated by the present-day inability



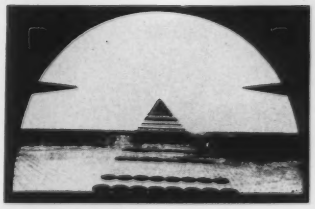
Research helicopter tests new controls that have proven satisfactory in the flight simulator. Built by Bell Helicopter, such flying laboratories are presently being used to evaluate a pictorial data display system which gives a dynamic artificial picture of the real world. The picture is presented on a spherical section of the cockpit window, directly in front of the pilot. In daylight the window is transparent, but at night or in bad weather the pilot reads flight pictures presented on the glass. Apparatus installed includes an electronic control system with various modes of stabilization, an airborne radar able to present radar mapping information and forward-looking obstacle information, and a central control computer to provide data to display components within the cockpit. Two helicopters are now in use.

Cockpit of the future, designed by Douglas Aircraft Co., is a paragon of simplicity. The data display screen will enable a pilot to fly along a predetermined pathway. Picture and pathway will be generated on the TV-type screen by a miniature computer which integrates flight information for the pilot.



of helicopters to fly under adverse weather conditions. Attempts to achieve all-weather capability in the past have lead to minor improvements in instruments and other existing equipment. This procedure has created a multitude of gages in the cockpit and, in some cases, has increased pilot confusion.

While better capabilities for bad-weather flight can be claimed for fixed-wing aircraft, new problems imposed by high-supersonic speeds will also require simplification in the cockpit for pilot efficiency.



Pictures seen on this data display system, under development by General Electric, give the pilot both landing data (above) and flight data. The in-flight picture indicates the plane is flying straight and level; the path goes to infinity (disappears) between the horizon markers.

Industry Backing NSPE Stand: "Engineer" Title for P.E. Only

U. S., Canadian Firms Endorse Registration

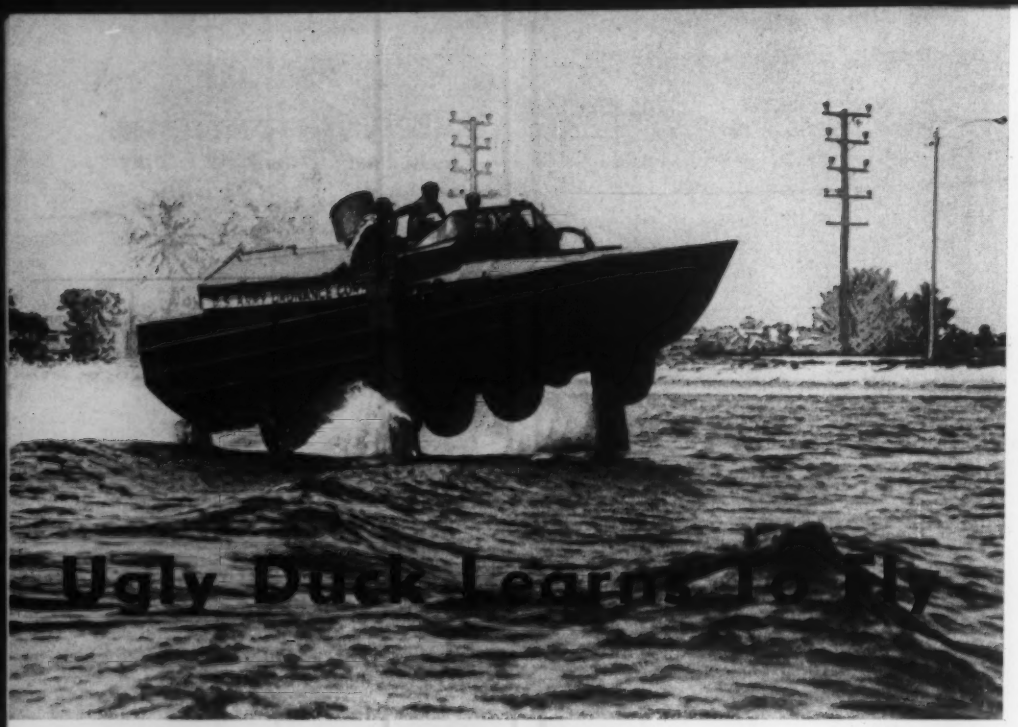
WASHINGTON, D. C.—The National Society of Professional Engineers reports what appears to be a trend in limiting use of the title "engineer" to those who are actually registered professional engineers. According to one firm which adopted the policy, there is a "very real sales reason" for it: Claim to the title by a non-registered or nongraduate engineer is resented by the customer or prospect who is a graduate or registered engineer.

Northern Electric Co. Ltd., largest employer of engineers in Quebec, announced early this year that only registered engineers under provincial law will be recognized as and assigned the title of engineer. The company stated, "It has been felt for some time that such action would be for the benefit of the engineering profession and would be an incentive for potential members to achieve professional recognition."

To comply with state engineering registration laws, Butler Mfg. Co., Minneapolis, permits use of the word "engineer" in a job title, if it is to be communicated to the public, only if the person is a registered engineer. The company's department heads are advised to continue encouraging engineer employees to become registered in their home states. Sales personnel will not use the title "sales engineer" on calling cards or correspondence unless they are registered engineers. Graduate but unregistered engineers in sales work will use the title "sales service representative" with the phrase "graduate engineer" appended to it.

In Massachusetts, Bay State Abrasive Products Co. has announced that "The term 'engineer' should be omitted from all titles . . . unless such person is registered as a professional engineer in the Commonwealth of Massachusetts."

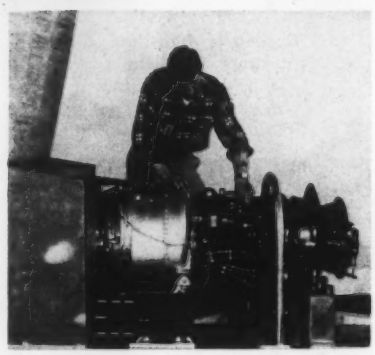
Substitute titles for Bay State employees will include "analyst" for personnel in the industrial engineering department and "machine designer" in the plant engineering departments. The company's Sales Engineering Dept. will keep that name as along as its manager is a registered professional engineer.



Riding on hydrofoils, the Flying Duck rises out of the water at a fairly sharp angle. Normal taxi run is 200 ft, but hydrofoils can be adjusted for 100-ft "takeoff" if necessary. With the angular body lifted clear, the Duck offers 60 per cent less drag. This, with the addition of the Lycoming gas turbine, makes possible the phenomenal speeds reported.

Ugly Duck Learns To Fly

Compact powerplant for the Flying Duck is this 860-hp gas turbine built by the Lycoming Div. of Avco Corp. Engine shaft is coupled directly to over-the-stern gearbox.

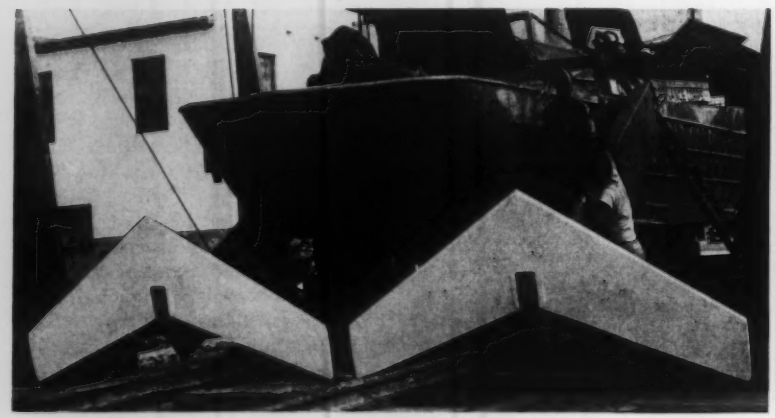


STRATFORD, CONN.—Hustled by the thrust of an 860-hp Lycoming gas turbine, a bulky DUKW lifts its ponderous hull and flys over the water at 50 mph. At conventional "Duck" speeds of 6 mph, the clumsy body starts to lift on three delicate-appearing hydrofoils; by the time it has reached a speed of 13 mph, the body is clear of the water, and at 50 mph, 4 ft of squarely planted legs show between hull and water.

Its speedy, but stable flight is not hampered by 4-ft waves. Impressive rough-water stability is achieved with an automatic pilot that senses waves ahead and adjusts the pitch of the hydrofoils to meet them. It is said to be the only craft able to catch an atomic submarine, and sub hunting is likely to be one of its roles—along with air-sea rescues, nose cone recovery, and missile launching on the run. Gross weight carried by the Flying Duck is as high as 26,000 lb. Limit for the World War II version was 19,000 lb.

Lycoming holds the prime Army Ordnance contract for the Flying Duck; Miami Shipbuilding Corp. is a participant in the development.

Hinged front foils (below left) are adjusted manually or automatically to change angle of attack. For land travel foils retract into brackets; tail housing holding tractor propeller retracts upward 6 ft.



"MILWAUKEE" Press Brake Uses TWIN DISC Air Clutch and Brake combination

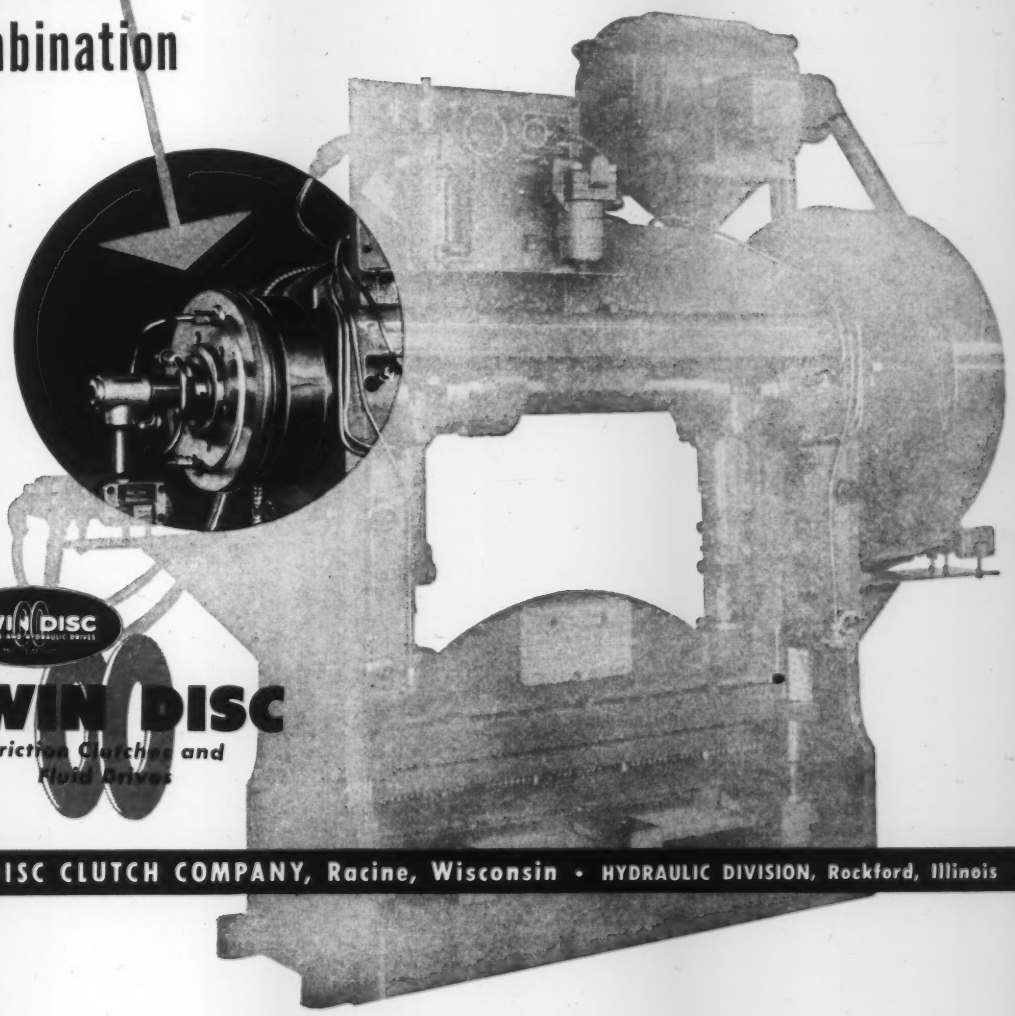
TWIN DISC mechanical clutches have long been standard equipment on Doelger & Kirsten "Milwaukee" Press Brakes. Now this well-known Milwaukee manufacturer has added the convenience and positive action of Twin Disc PO Air Clutches to its new 25 ton press.

Two 8" air clutches are used in this model with one acting as a clutch, the other as a brake. Mounted at opposite ends of the crankshaft, these sensitive clutches provide instantaneous response . . . permit delicate "inching" and single stroke operation.

Twin Disc PO Air Clutches feature an exclusive cartridge-type diaphragm of nylon-reinforced neoprene. Advantages in machine tool applications include:

- Low cost in relation to torque capacity.
- Automatic wear takeup . . . no adjustments for the life of the plates.
- Clutch mass properly distributed relative to friction area.
- Narrow width and overall compactness.

If you're looking for lighter, more compact remote control of power transmission without complicated linkage, Twin Disc PO Air Clutches are well worth investigating. Sizes from 8" to 42" with one, two or three plates. Pressures to 130 psi. Write for Bulletin 304-A.



TWIN DISC

Friction Clutches and Fluid Drives

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin • HYDRAULIC DIVISION, Rockford, Illinois

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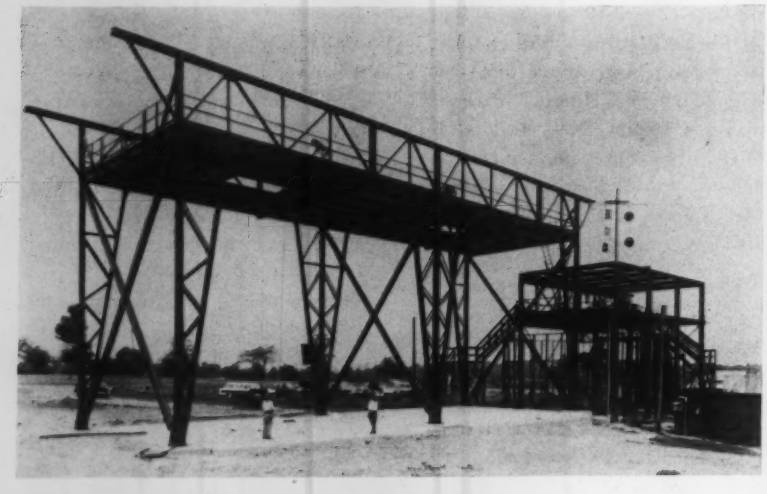
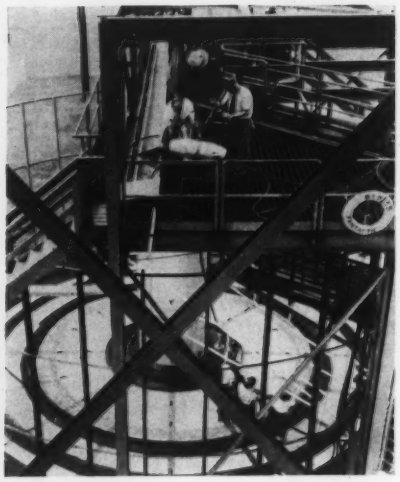
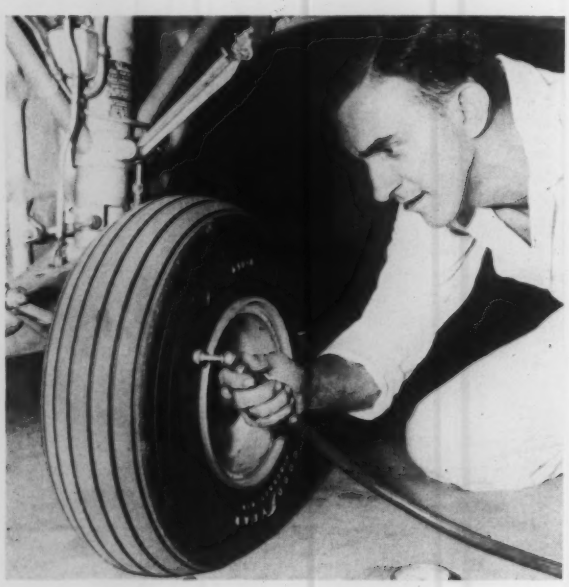




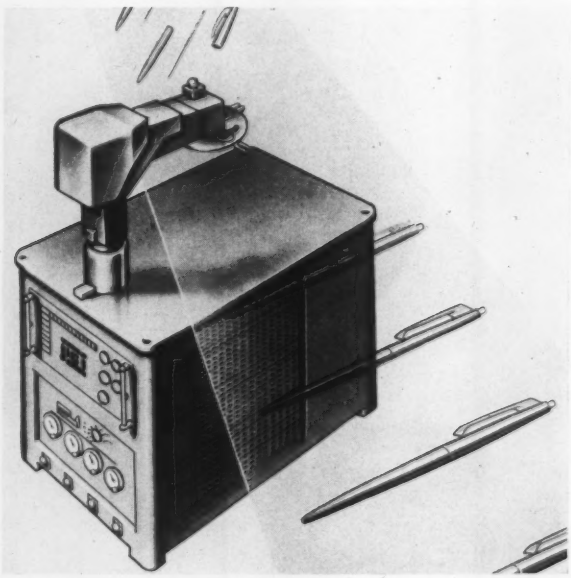
Bell Builds Dry-Land Cable Ship

Riding at anchor 28 miles inland, this mockup of an ocean-going cable ship (dubbed Fantastic) will help bring about a technical revolution in shipboard machinery and cable-laying techniques. Bell Telephone Laboratory engineers built the skeletonized laboratory because it was more practical and cheaper than chartering an actual cable ship for their extensive experiments. Cable tanks are in the "hold" (ground level, right); working decks stand 50 ft in the air. During cable-laying experiments, cable is pulled from the tanks, through a cable engine and "overboarded." Maritime signals flying at the yardarm—set by nautical-minded engineers enjoying their roles as seamen—warn any other ships in the New Jersey hills to stand clear, "Cable-laying operations underway."



Needle Inflates Aircraft Tire

Sidewall-inflated tires, now original equipment on Cessna and Beech aircraft, are aimed at solving long-standing wheel-design problems. Tubeless, the new tires are inflated just as a football is filled—by inserting a standard inflation needle in the sidewall. Because wheel-weakening valve holes are eliminated (they're stress-concentration points), use of the sidewall-inflated tires will strengthen wheels and give more flexibility in brake location. Goodyear Tire & Rubber Co., developer of the tires, says they've withstood crush tests up to 36 tons at pressures as high as 385 psi.



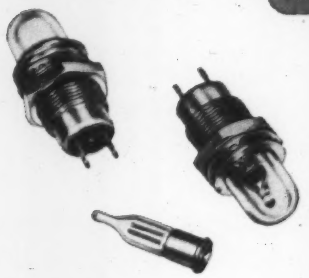
Robot Thrives on Routine

No fumble-fingered workman is TransfeRobot—an automatic machine that teams a mechanical arm, a many-fingered hand, and an electronic equivalent of a small portion of the human brain. Quickly taught to repetitively assemble products as diverse as cigarette lighters and guided missiles, the machine is dexterous and precise. Once set up for a task (by programming the computer), it carries on until reassigned. Developed by Robodyne Div., U. S. Industries Inc., the assembly and machine operating robot is said to work efficiently with existing equipment.

HETHERINGTON

SWITCHES • INDICATOR LIGHTS • SPECIAL ASSEMBLIES

ENGINEERING NEWS



"RESISTORIZED" NEON INDICATOR

...to MIL-L-6723 (ASG)

Keeping pace with the needs of miniaturized, ruggedized, transistorized equipment of minimized dimensions, Hetherington engineers have found space for an internal resistor in an indicator light that already is only $1\frac{33}{64}$" long. It's known as the Hetherington L15,000 Series and it's designed to MIL-L-6723 (ASG), Drawing MS25257. With the built-in resistor, the unit operates on 115 volts using MS25252-NE2D neon lamps.

If low-voltage incandescent lamps are preferred, $1\frac{1}{32}$" in length can be saved by specifying the still smaller L14,000 Series, designed to MS25256.

Both types have corrosion-resistant anodized aluminum sockets with integral mounting flanges, panel indexing tabs, and two solder-lug terminals. Lamps replace from the front by unscrewing the wide-visibility lenses. Center contacts are large silver-plated buttons, internally spring-loaded to resist vibration.

Complete specifications on both MIL-L-6723 (ASG) lights are shown in Data Sheet L-5a.

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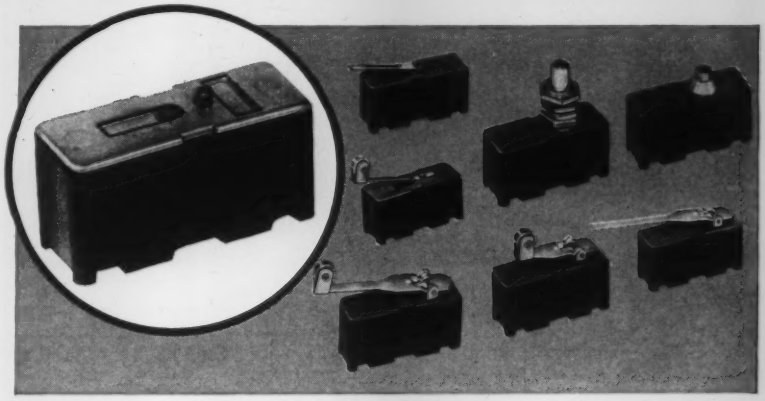

New 20-AMP PRECISION SWITCHES

braced for toughest service!

Rigidly-braced phenolic cases of Hetherington Series S2A "HiPAC" Switches pave the way toward greater dependability and unsurpassed repeatability in critical control and positioning circuits. Molded-in safety limits prevent over-travel damage to the blade-type movable contacts. Extra bracing around mounting holes prevents case distortion from excessive mounting pressures. On the bottom, molded-in barriers and cup washers provide long creepage paths and positive separation between terminals and leads.

U. L. rated "HiPAC" Switches are presently available with any of eight actuators. All are interchangeable with other precision switches of equivalent ratings. Quantities for samples or small production runs are stocked for immediate delivery by over 50 leading electronic parts distributors throughout the country.

For detailed specifications on the "HiPAC" line, write for Hetherington Bulletin S-9.

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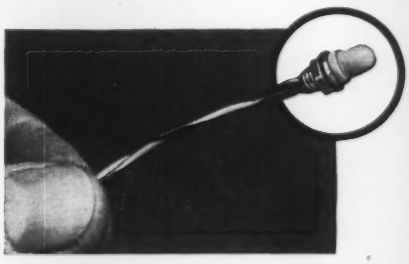

TINY LIGHT with a BRIGHT FUTURE

One of the smallest indicator lights ever developed, the Hetherington L10,000 Series measures only $\frac{15}{64}$" in diameter by $\frac{35}{64}$" long. It's equipped with wire leads and a threaded aluminum bushing that mounts in a clearance hole for a #10 screw. Secret of the L10,000's midget size is a fully moistureproof lamp/lens assembly that is molded to the mounting stem.

Designed for electronic equipment requiring components of minimum size and weight, the L10,000 gives bright, wide visibility for 60,000 hours at 5 volts dc. Many translucent colors are available.

Dimensions of the L10,000 are available on request.

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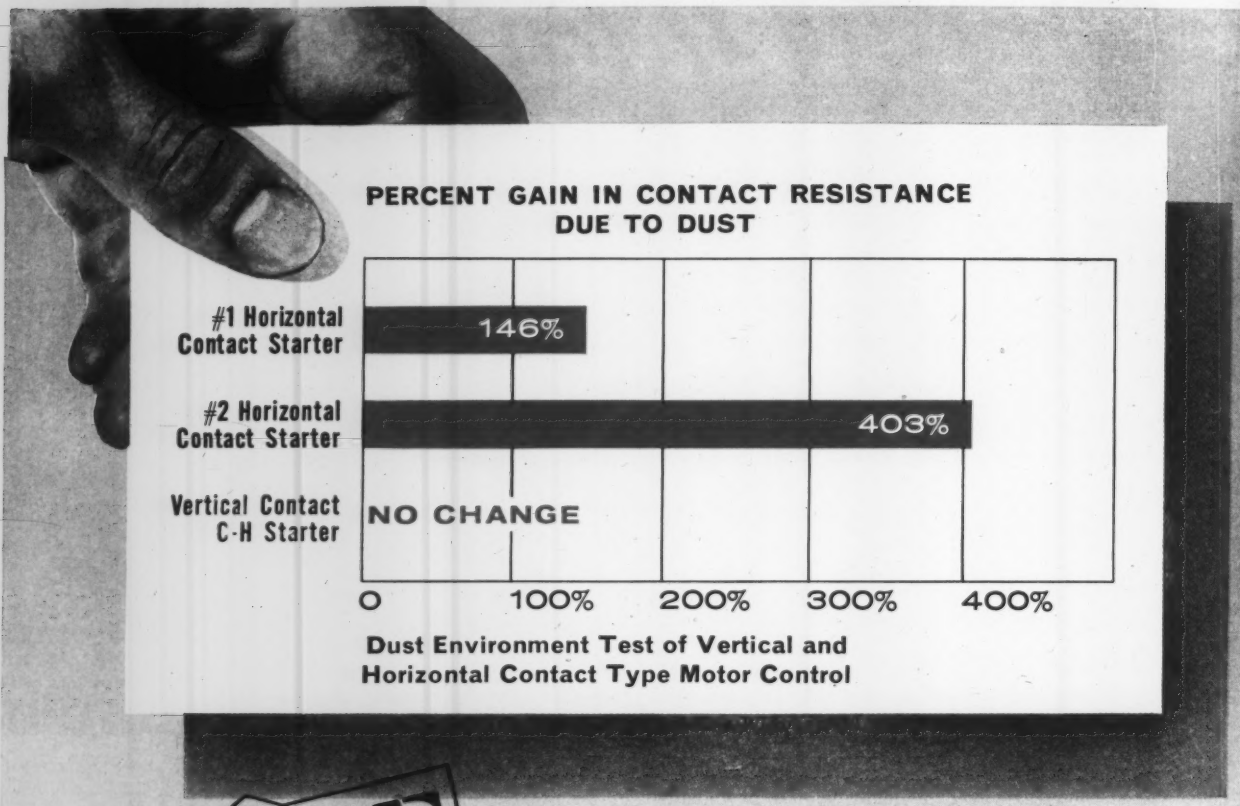
HETHERINGTON INC. DELMAR DRIVE, FOLCROFT, PA. • 139 Illinois St., El Segundo, Calif.

A Controls Company of America Subsidiary



PROOF OF PERFORMANCE

Vertical *dust-safe* contacts keep Cutler-Hammer Three-Star Motor Control working better...working longer

Standard dust chamber used to compare performance of vertical and horizontal contact type motor starters in dust environments

"Dust can't collect on a vertical surface." This is a simple fact, but an important one to users of motor control. To function properly the contacts in motor control *must* stay clean, free from all forms of dust under all operating conditions. And because dust can't collect on a vertical surface, only vertical contacts are truly *dust-safe*. For proof look at the results of this test.

Both horizontal and vertical contact type motor starters were subjected to a dust environment for four hours. The vertical contacts proved their immunity to dust by maintaining a constant contact resistance. But the contact resistance of horizontal contacts skyrocketed, and as contact resistance increases so does heating, pitting and wear, resulting in rapid contact failure.

These are the facts . . . facts which show you why it's wise to standardize on Cutler-Hammer Three-Star Motor Control with vertical *dust-safe* contacts.

CUTLER-HAMMER

Cutler-Hammer Inc., Milwaukee, Wis. • Division: Airborne Instruments Laboratory. • Subsidiary: Cutler-Hammer International, C. A.
Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.; Intercontinental Electronics Corporation.

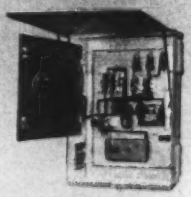
CUTLER-HAMMER CONTROL C-H

Circle 419 on Page 19

Vertical *dust-safe* contacts are standard in all Cutler-Hammer Three-Star Motor Control

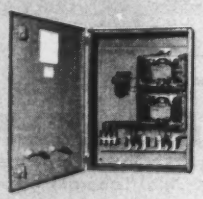
NON-REVERSING STARTERS AND CONTACTORS

CONTROL RELAYS



OIL WELL PUMPING CONTROL

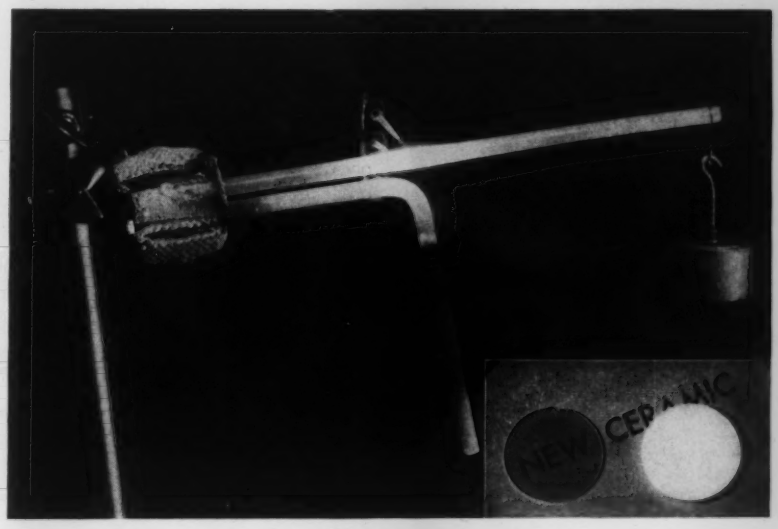
REVERSING AND MULTI-SPEED STARTERS AND CONTACTORS



REDUCED VOLTAGE STARTERS

AND MORE...

Write today for Pub. EN150-U243 Cutler-Hammer Inc., Milwaukee 1, Wisconsin.



High-Temperature Transparent Ceramic

Cousin of the sapphire (which is really a single-crystal aluminum oxide), a new high-strength, temperature-resistant ceramic transmits 90 per cent of light in the visible spectrum. Developed by General Electric Co., Schenectady, N. Y., the polycrystalline material is pressed from powdered aluminum oxide in a new process. Because microscopically small pores and bubbles normally present in a ceramic are removed, the end product is translucent. A bar of the material heated by a blow torch easily supports a 50-gm weight, even when its temperature is as high as 3200 F. For comparison, a fused-quartz bar bends under its own weight at a temperature of 2350 F. Translucence is such that one can read through a polished wafer placed flat against printed matter (insert).

Research Spending Increases in 1959

NEW YORK — American companies budgeted 12 per cent more money for research and development this year, even though last year saw record-breaking highs in new product spending. Latest American Management Association survey of 600 corporations indicates 64 per cent of the firms queried have increased product development and research expenditures, 8 per cent have left them virtually unchanged, and 28 per cent have cut them back.

The automobile industry is on top with a 32 per cent increase over last year. Then come instruments (29.7 per cent), electrical machinery (23.8) and metalworking machinery (21.7). Only one group—miscellaneous machinery and parts—showed a decline.

Previous surveys showed a 4 per cent increase in the '58 research budget over 1957. Figures tabulated at year end have revealed new product expenditures (on a per cent of the sales dollar basis) were 3.2 per cent for '58 as compared to 2.8 per cent for '57. High spenders in '58 were the rubber industry (9.3 per cent), general industrial machinery (7.0), instruments (4.8), chemicals (4.3), electrical machinery (4.1).

Hole to Earth's Interior Will Be Drilled in Ocean

WASHINGTON—The hot, viscous interior of the earth—whose substance has been one of Nature's best-kept secrets—may be reached and sampled within four years. A new scheme sponsored by both the National Academy of Sciences and the National Research Council intends to do the job by sinking an 18,000-ft bore-hole under several thousand feet of ocean water.

Transitional boundary between the earth's outer crust and the underlying mantle lies close to the earth's surface at certain points on the ocean floor. Once problems of

THESE HASTELLOY BALLS

STOP INDUSTRIAL HEARTBURN

ITI balls of Hastelloy B and C are particularly resistant to pressurized hot solutions; for their structure and analysis enables them to shrug off corrosion and wear. Thus they're ideal for use in the petroleum, chemical and food processing industries, and in many other applications where balls must withstand acids, salts, wet chlorine and other corrosive agents.

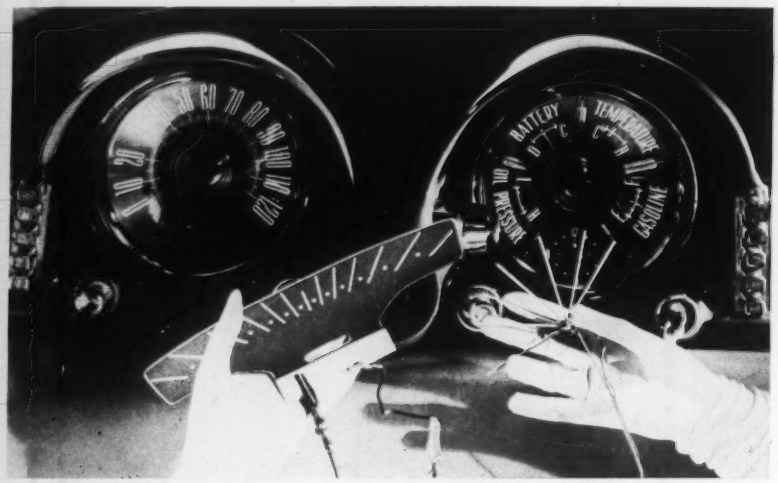
These precision balls are available from stock in 16 standard sizes from ⅛" to 1½". They can also be furnished in any special size desired.

Write **for prices and specifications.**

INDUSTRIAL TECTONICS, Inc.
MANUFACTURERS OF PRECISION BALLS AND BEARINGS
3685 Jackson Road, Ann Arbor, Michigan

deep-water drilling can be solved, reaching this mantle by present-day offshore drilling techniques seems feasible.

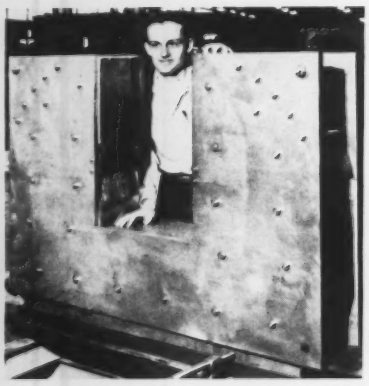
Advantages of drilling on the ocean bottom to pierce the earth's crust are numerous, and the project is expected to add considerably to the meaning of great stores of geophysical data accumulated during past decades. In addition, samples of the ocean's sedimentary floor might reveal the nature of marine organisms back through the ages to the origin of life itself. Other additions to modern technology promised by the project include new drilling techniques, new information on petroleum deposits, and basic techniques that will contribute to eventual harvesting of mineral wealth of the oceans.



Soft Lights for Chrysler

Instrument panels in 1960 Chryslers and Imperials will be illuminated by electroluminescence. Numerals and letters on gages and dials will be backlighted by wafer-thin lamps that produce a blue-green light; pointers will glow in contrasting colors. Sylvania Electric Products Inc., developer of Chrysler's Panelescent lighting, says the new EL lamps are virtually unbreakable and have a life expectancy, at maximum light output, of more than 10,000 hr. This contrasts to a 300 to 1000-hr life for the typical standard-filament bulb. In addition, EL provides a soft, shadowless, area light source. The lamp itself consists of a thin piece of metal coated with several ceramic layers and electroluminescent phosphors, all hermetically sealed in glass. Thickness is less than 1/50 in.

Big Attraction



World's largest permanent magnet will help pump liquid sodium in a breeder reactor to be operated by Argonne National Laboratory for AEC. Built by Arnold Engineering Co., Marengo, Ill., the magnet weighs 1720 lb and is made of Alnico V. Overall dimensions are 52½ by 36 by 10 in. Density at the center of the gap is 1100 gausses, and almost 500,000 ampere turns were needed to magnetize the unit. Although it is customary to use an electromagnet in pumping liquid sodium, a permanent magnet is necessary in this particular case because it will be completely surrounded by the liquid metal.

Circle 421 on Page 19→

Circle 420 on Page 19

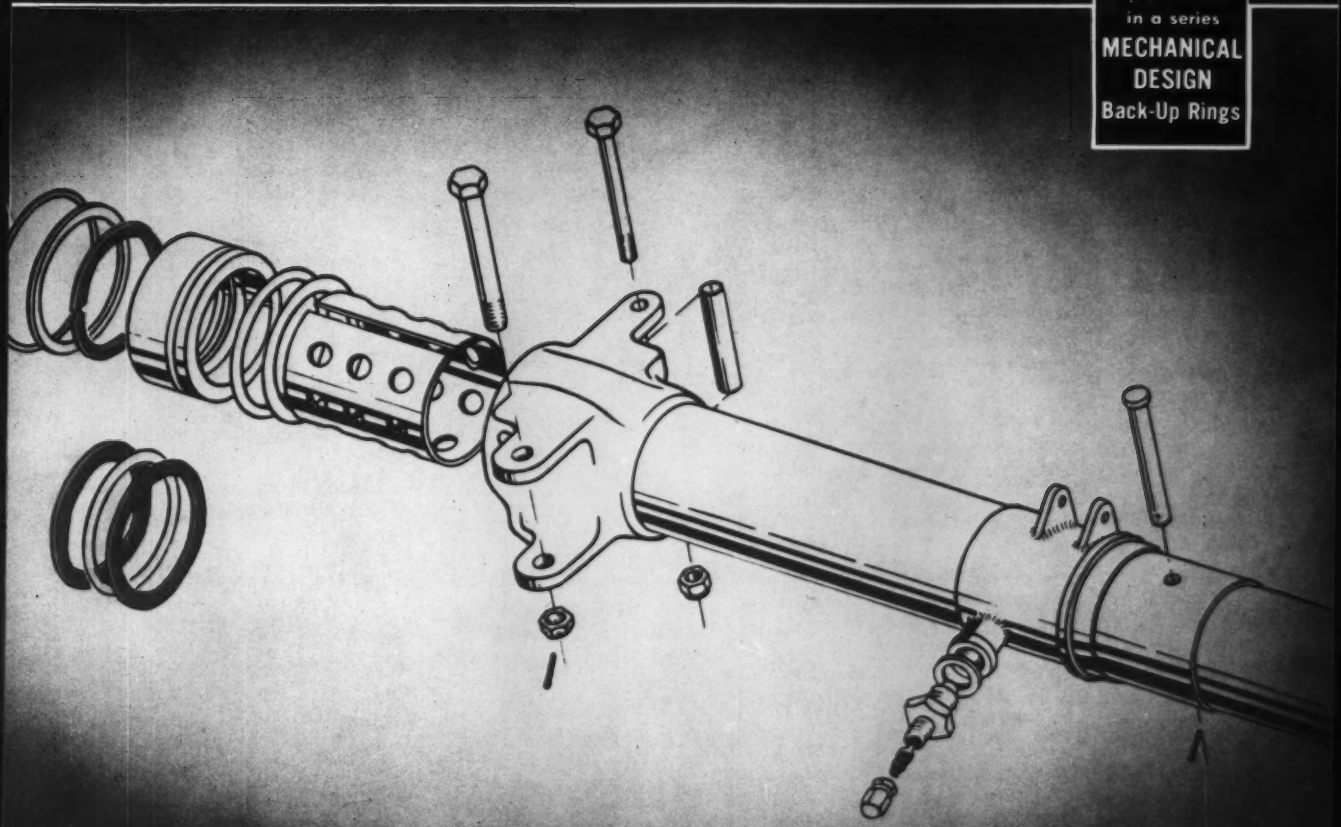
DU PONT

ENGINEERING FACTS ABOUT

TEFLON®

FLUOROCARBON RESINS

Number M-5
in a series
MECHANICAL
DESIGN
Back-Up Rings



Back-up rings of TFE resins reduce frictional drag . . . improve seal efficiency

The hydraulic system shown above is used in the landing gear and nose gear of commercial aircraft. According to the manufacturer, the use of back-up rings fabricated from a TEFLON TFE resin results in reduced frictional drag, improved operation and lower over-all costs.

The exceptionally low coefficient of friction of TFE fluorocarbon resins—less than .04—is one of the reasons why back-up rings made of TEFLON help assure efficient seal operation in any application. In operation, some of the TFE resin is deposited from the back-up rings to the rubber O-rings, which provides a further reduction of frictional drag. Back-up rings of TFE resins also increase the operating life of the seal, because they prevent extrusion of O-rings and reduce spiral twisting. They provide longer life, safer and more reliable performance and reduced maintenance problems in everyday seal designs, as well as in applications that involve adverse conditions, such as extremes of temperature or corrosion problems.

On the next page you will find additional information on the properties of TEFLON TFE resins as they relate to back-up rings, and detailed considerations of design opportunities they provide in many types of seal applications.

TEFLON is Du Pont's registered trademark for its fluorocarbon resins, including the TFE (tetrafluoroethylene) resins discussed herein.

OVER

Back-up rings of TFE resins: DESIGN CONSIDERATIONS

The problem of O-ring extrusion

In general, O-rings provide effective sealing in wide ranges of temperatures and pressures, with the added advantages of sealing in both directions and making possible space savings. One drawback of O-rings, however, is their tendency to extrude into the clearances under fluid pressure, as shown in Figure 1.

O-ring extrusion can be prevented by the use of back-up rings of TFE resins. These thin rings are much harder than are rubber O-rings, yet they do deform enough to provide zero clearance for the O-ring. Figure 2 shows a rule-of-thumb chart that may be used as a guide on static or dynamic O-rings of rubber to indicate whether or not anti-extrusion rings should be used. There are many additional reasons why TEFLON TFE resins are rapidly replacing other materials for use in back-up rings. The following advantages relate to back-up rings as anti-extrusion devices:

Back-up rings of TEFLON TFE resins

1. Back-up rings of TFE resins are easier to make and buy to the close tolerances required in a precision sealing installation, as compared with leather, the previous standard material. The result is increased reliability, uniformity and reproducibility.

2. Back-up rings of TFE resins are compatible with all hydraulic fluids. They are essentially chemically inert and do not embrittle or fibrate.

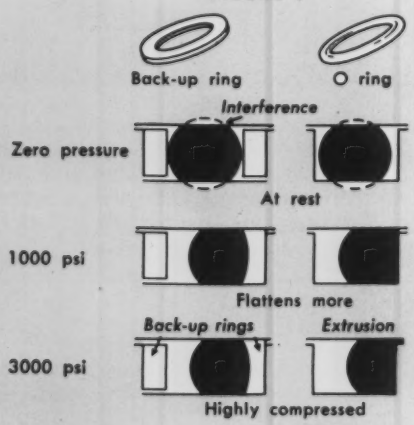
3. Installation is easier; rings of TFE resins are usually scarf-cut and can be slipped over a shaft; there is no right and wrong side; and they require no oil soaking or drying out to install.

4. TFE resins retain their outstanding properties up to 500°F., and reinforced back-up rings of TFE resins are being used at even higher temperatures.

5. The exceptionally low coefficient of static friction of TFE resins—0.04—reduces break-away friction. TFE resins deposit a molecular coating which in turn imparts low friction to mating surfaces.

6. Yet with all these advantages, back-up rings of TFE resins can be installed at a *cost saving* over back-up rings of leather.

FIGURE 1



Additional performance advantages

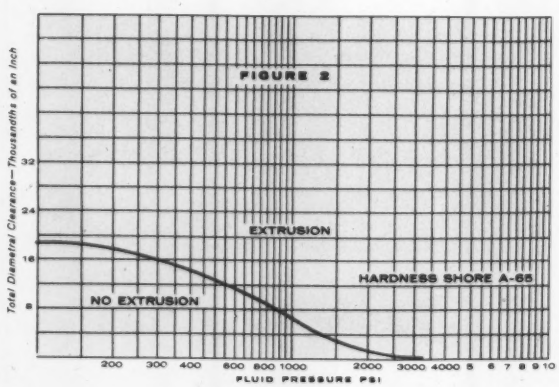
As TFE resins become more and more widely used in anti-extrusion rings, additional advantages from the use of TFE resins in back-up rings have become evident. And, even if extrusion does not present a problem, the advantages of using a back-up ring of a TEFLON TFE resin can greatly improve your O-ring seal installation.

1. Longer O-ring life. The majority of O-ring failures occur either by nibbling or spiral failure. The zero clearances provided by TEFLON TFE resins in back-up rings reduce the tendency to nibbling; and spiral failure is reduced because of the molecular coating of TEFLON TFE resins deposited on the cylinder surface, permitting the rubber to slide evenly without slipping or rolling.

2. Reduction in break-away friction of O-rings. The molecular layer of TFE resin deposited on cylinder walls decreases the break-away friction of rubber O-rings, which otherwise may be 50 to 100 per cent higher than the running friction.

3. Ease of removal of old O-rings. The anti-stick properties of TEFLON TFE resins prevent sticking of old rubber in the groove, thus reducing replacement time and insuring proper seating of the new rubber seal.

4. Savings in machining. The standard recommended 32 rms surface finish on ring grooves is an expensive machining operation. When using back-up rings of a TEFLON TFE resin, this requirement is not as critical, and the groove may be left in the as-machined condition, normally 64 to 120 rms. Savings in machining alone often pay for the small cost of a back-up ring of a TEFLON TFE resin.



FOR MORE INFORMATION...

Further details on the properties and design characteristics of TEFLON TFE fluorocarbon resins, and their application to lip seals and all types of seals, may be obtained from your local supplier. You'll find him listed under "Plastics—Du Pont" in the Yellow Pages. Supplementary engineering data on the properties of TFE resins is available on request from your supplier or from: E. I. du Pont de Nemours & Co. (Inc.), Advertising Department, Room T-25102, Nemours Bldg., Wilmington 98, Delaware.

In Canada: Du Pont of Canada Ltd., P.O. Box 660, Montreal, Quebec.

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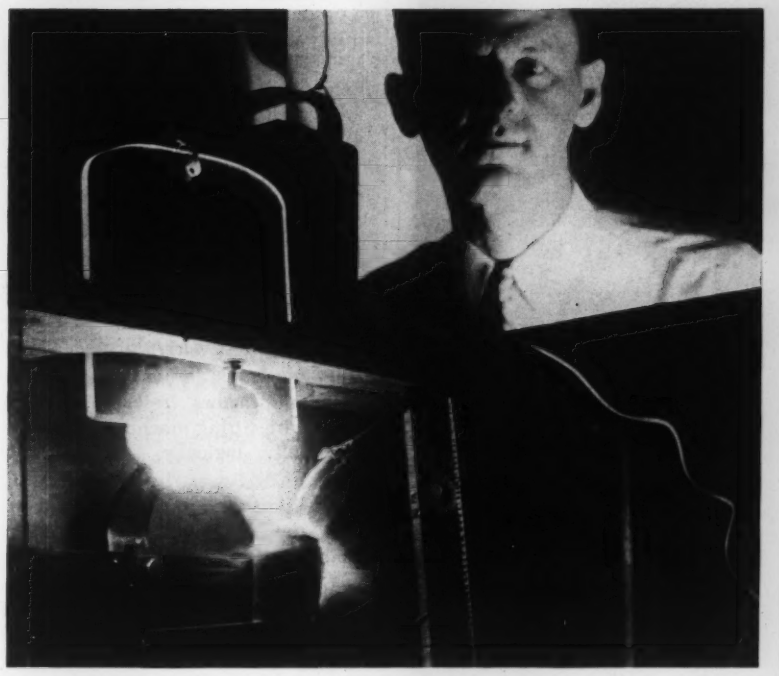
TEFLON®

TFE-FLUOROCARBON RESINS

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY



Underwater Lightning Develops 6000 hp

Direct conversion of electricity into mechanical power is accomplished by underwater lightning created in a "spark bomb." Developed by Republic Aviation Corp., Farmingdale, N. Y., the device releases stored up electrical energy with a force equivalent to 6000 hp. The released energy is being used experimentally for metal-forming operations that normally use hydraulic press equipment. When the discharge switch is released, the "explosion" (complete with lightning and thunderclap) causes a shock wave to travel through the water at extremely high velocity. The shock wave does the forming work.

New Tools Can Increase Engineers' Output

Assistance in Routine Tasks Makes Time for Ingenuity

Los Angeles—Giving the engineer more theoretical and mechanical tools will "decontrol" him and increase his engineering output, according to Harry H. Goode, Electrical Engineering Dept., University of Michigan. Mr. Goode points out that the amount of engineering required per engineer has increased greatly because of the complexity of our mode of living and greater productivity required by a growing population.

Mr. Goode told attendees of the ASME-AIEE Engineering Management Conference that in college an engineering student is told repeatedly of the creative nature of his chosen career; yet his first job often consists of nothing but routine tasks. This early indoctrination in routine tends to form a pattern of thinking so that as an engineer is assigned bigger tasks, he tends to regard them merely in terms of sets of routines. By the time he becomes an engineering manager, it is difficult for him to conceive of the engineering function being carried out in any other fashion.

Engineers and engineering managers are concerned with:

Scheduling	Meetings
Costing	Report reading
Library research	Supervision
Analysis	Report writing
Judgment	Administration
Decision-making	Ingenuity
Technical work	Planning

Some of these tasks can be accomplished more efficiently by some-

IT'S THE FINISH THAT COUNTS

IN TUBING TOO!

TESTS PROVE PRECISION FINISH UNSURPASSED

Shape, size, alloy are important in tubing and Precision Tubing excels in all . . . but finish is an outstanding quality of Precision Tubing where specified . . . and at no extra cost.

Precision Tubing is available in clean, scratch-free finishes suitable for anodizing or plating to mirror finishes. In sizes from .010" to 1.125" O.D. in copper, brass, aluminum, up to ⅝" O.D. in nickel and nickel alloys.

Other Precision Tubing is available in straight lengths, coils, preformed to specified shapes . . . and also as Coaxitube the metal shielded coaxial conductor. Whatever your designs or requirements for fine accurate tubing at regular tube prices order Precision Tubing. Write for complete technical data to Dept. 10, Precision Tube Company, Inc., North Wales, Pa.

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PRECISION TUBE COMPANY

Circle 422 on Page 19

Difficult Teflon* & KEL-F† Moldings Offer No Problems

Our specialty is precision molding where close tolerances, intricate shapes, and where thin wall sections are involved. Garlock's United States Gasket Plastics Division has the personnel, the facilities, the unequalled experience in handling tough fluorocarbon plastics.

Guarantee yourself the best parts, and the right price—ask for a quote on any molding problem concerning TEFLON T.F.E. and KEL-F. Call us, too, for fluorocarbon sheets, discs, tape, rods, tubing, bars, and cylinders from the world's largest and most complete stock.

United States Gasket

For Prompt Service, contact one of our **26** sales offices and warehouses in the U.S. and Canada, or write The Garlock Packing Company, Palmyra, New York.

*DuPont Trademark for T.F.E.-fluorocarbon resin
†M.M.&M. Trademark

Plastics Division of GARLOCK

thing other than the engineer (e.g., a machine). The following tools, both theoretical and equipment-type, can relieve the engineer of some of his routine jobs.

Linear programming, a technique for solving sets of inequalities which may be boundary conditions on a problem.

Queueing theory, which allows the analysis of events in terms of the times it takes them to occur, rather than in terms of the actual function being performed.

Human-factors research, which deals with fitting machines to men—physically, logically, and in training.

Decision theory, which would affect the judgment and decision-making aspects of an engineer's job.

Information theory permits estimating quantitatively the amount of information contained in a fixed storage of information, the amount flowing over a channel of communication, and the amount taken in by receptors such as human eyes or radar.

High-speed digital computer, which is capable of doing all sorts of problems requiring repetitive processes.

High-speed communication nets permit an exchange of information between computers as well as persons.

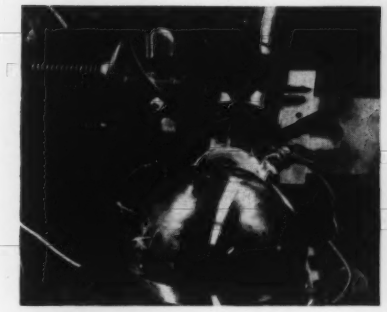
Large memory of a computer permits storing and retrieving information used in costing, library research, paper administration, and report writing.

Input and output equipment—high-speed printer, oscilloscope—will reduce time required for analysis.

Fast reproduction equipment for all information records—drawings, written material, calculations—will act as a "lubricant" for all of the engineering functions.

Engineering decontrol, according to Mr. Goode, consists of removing some of the engineer's routine tasks and allowing the higher functions of ingenuity and planning to occupy a greater amount of time. Mr. Goode presented his ideas in a paper, "New Methods of Engineering Decontrol," at the management conference held in Los Angeles September 17 and 18.

Circle 423 on Page 19



Rotor for New Gyroscope Is Suspended in Vacuum

Beryllium sphere machined to within 15 mu in. and electrically suspended in a vacuum forms the rotor for a space-age gyroscope. Because the accuracy of even the extremely accurate conventional gyros may not be good enough for guidance of vehicles in deep space, Minneapolis-Honeywell Regulator Co., Minneapolis, Minn., is developing this new type. The sphere will rotate at high speed for a long time without assistance when properly vacuum suspended.

Meetings and Shows

Oct. 6-7—

Electronic Industries Association. Conference on Value Engineering to be held at the University of Pennsylvania, Philadelphia. Further information is available from EIA headquarters, Room 650, 11 W. 42nd St., New York 36, N. Y.

Oct. 8-10—

American Society of Tool Engineers. Semiannual Meeting to be held at the Chase-Park Plaza Hotels, St. Louis. Further information is available from ASTE, 10700 Puritan Ave., Detroit 38, Mich.

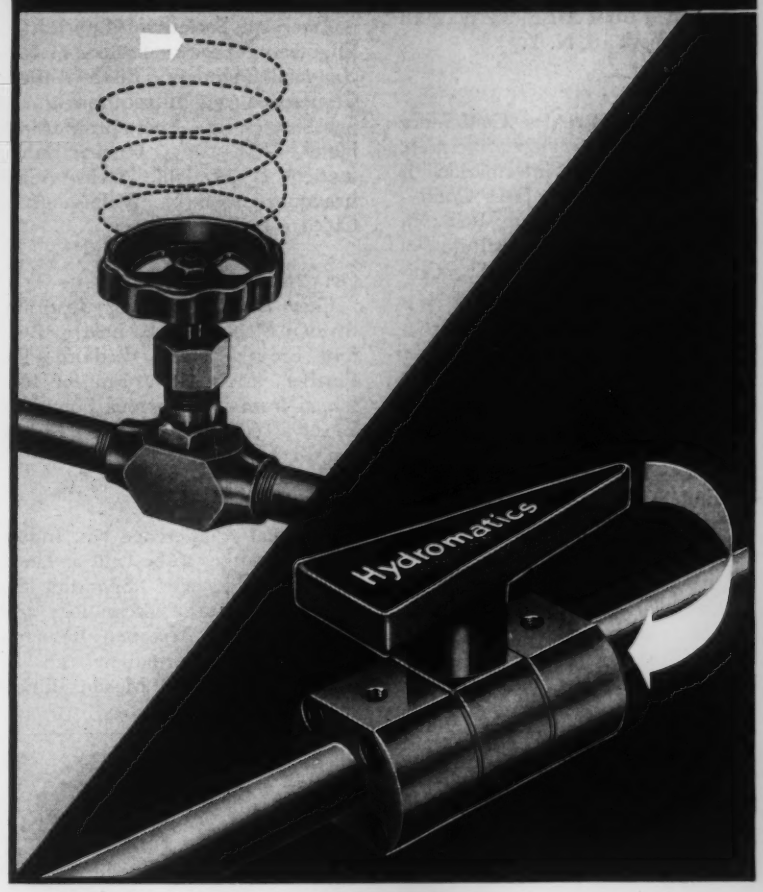
Oct. 11-16—

American Society for Testing Materials. Third Pacific Area National Meeting to be held at the Sheraton-Palace Hotel, San Francisco. Further information can be obtained from ASTM headquarters, 1916 Race St., Philadelphia 3, Pa.

Oct. 11-16—

American Institute of Electrical Engineers. Fall General Meeting to

FLO·BALL 715
makes needle valves obsolete



WHICH VALVE CLOSES FASTER?

Unlike the many turns required to operate a needle valve, the Hydromatics ***FLO•BALL 715,*** shown on the bottom, closes instantly with a mere ¼ turn . . . **positive action** at flow pressures up to 3,000 psi with just a 4 inch-pound torque! And the arrow-shaped handle shows both open and closed positions at a glance. Exclusive ***FLO•BALL*** straight-thru design has 100% flow efficiency—more than double the flow of needle valves.

Ideal for leakproof control of air, vacuum, steam, water, fuels, oils, kerosene, alcohol, etc., the ***FLO•BALL*** features zero leakage, universal mounting, removable flanges, and all stainless steel construction.

Write today for a complete catalog describing this valve and others for corrosive and cryogenic media. Also special designs for throttling flow control.

The *FLO•BALL* costs no more than old fashioned screw-type valves!

Exceptional engineering employment opportunities—write today!

Hydromatics, Inc.

FLO·BALL

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Circle 424 on Page 19

be held at the Morrison Hotel, Chicago. Additional information can be obtained from AIEE, 33 W. 39th St., New York 18, N. Y.

Oct. 12-14—

National Electronics Conference to be held at the Hotel Sherman, Chicago. Further information is available from M. J. Jans, Conference Secretary, Armour Research Foundation, Illinois Institute of Technology, 10 W. 35th St., Chicago 16, Ill.

Oct. 19-20—

Magnesium Association. Fifteenth Annual Convention to be held at the Hotel Roosevelt, New York. Further information can be obtained from association headquarters, 122 E. 42nd St., New York 17, N. Y.

Oct. 20-22—

American Standards Association. Tenth National Conference on Standards to be held at the Sheraton-Cadillac Hotel, Detroit. Further information can be obtained from association headquarters, 70 E. 45th St., New York 17, N. Y.

Oct. 20-22—

American Society of Lubrication Engineers-American Society of Mechanical Engineers. Sixth Annual Conference on Lubrication to be held at the Sheraton-McAlpin Hotel, New York. Further information is available from ASLE headquarters, 5 N. Wabash Ave., Chicago 2, Ill.

Oct. 21—

Cast Bronze Bearing Institute. Annual Meeting to be held at Bedford Springs Hotel, Bedford, Pa. Further information can be obtained from Non-Ferrous Founders' Society, 1607 Chicago Ave., Evanston, Ill.

Oct. 22-23—

National Conference on Industrial Hydraulics to be held at Hotel Sherman, Chicago. Sponsors are Illinois Institute of Technology and its affiliate, Armour Research Foundation. Information can be obtained from R. D. Meade, Illinois Institute of Technology, 3300 Federal St., Chicago 16, Ill.

Oct. 25-28—

American Gear Manufacturers Association. Fall Meeting to be held at the Edgewater Beach Hotel, Chicago. Further information can be obtained from AGMA, 1 Thomas Circle, Washington 5, D. C.

Oct. 26-28—

Society of Automotive Engineers Inc. National Transportation Meeting to be held at the La Salle Hotel, Chicago. Further information is available from SAE, 485 Lexington Ave., New York 17, N. Y.

Oct. 26-30—

Society of Photographic Scientists and Engineers. National Conference and Exhibit to be held at the Edgewater Beach Hotel, Chicago. Further information can be obtained from society headquarters, Box 1609, Main Post Office, Washington, D. C.

Oct. 27-28—

Society of Automotive Engineers

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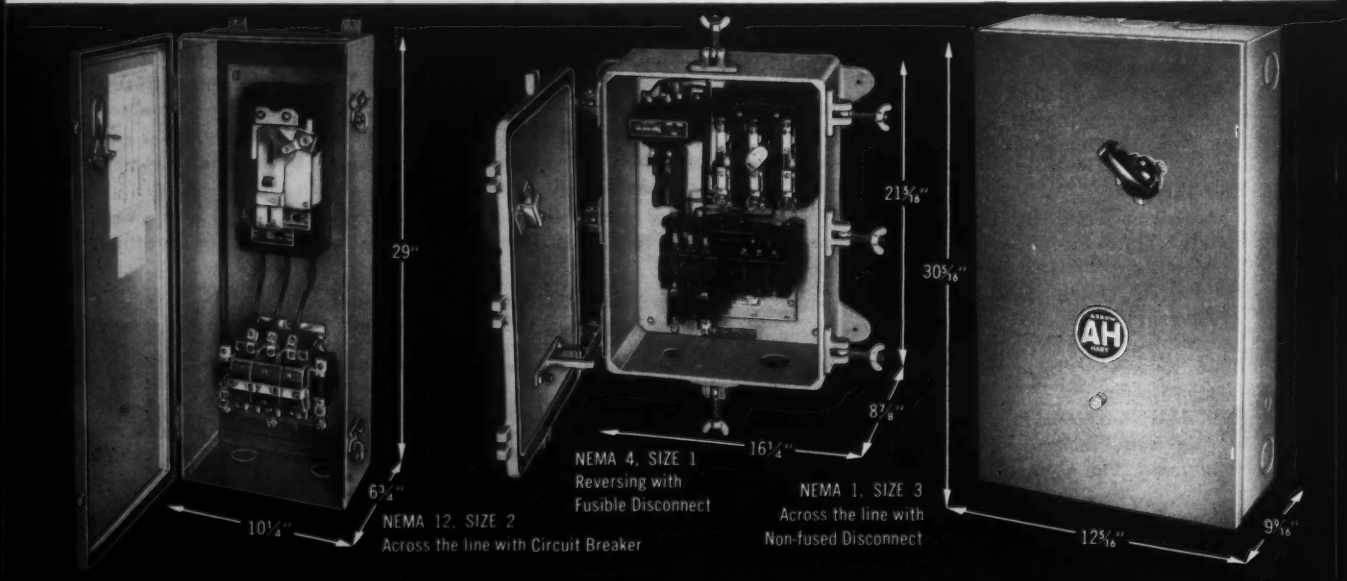
Announcing: A COMPLETE LINE OF COMBINATION STARTERS UP TO 100 HP, 440 VOLTS AC NEMA SIZES 0, 1, 2 and new sizes 3 and 4



Inc. National Diesel Engine Meeting to be held at the La Salle Hotel, Chicago. Additional information can be obtained from society headquarters, 485 Lexington Ave., New York 17, N. Y.

Oct. 28-29—

Six Annual Computer Applications Symposium, sponsored by Armour Research Foundation of Illinois Institute of Technology, to be held at the Morrison Hotel, Chicago. Additional information is available from M. J. Jans, Conference Secretary, Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.

Oct. 28-30—

Society of Automotive Engineers Inc. National Fuels and Lubricants Meeting to be held at the La Salle Hotel, Chicago. Further information is available from SAE, 485 Lexington Ave., New York 17, N. Y.

Oct. 30-Nov. 1—

American Society of Refrigerating Engineers. Semiannual Meeting to be held at the Traymore Hotel, Atlantic City, N. J. Additional information can be obtained from society headquarters, 234 Fifth Ave., New York 1, N. Y.

Nov. 2-5—

Air-Conditioning and Refrigeration Institute. Exposition of the Air-Conditioning and Refrigeration Industry to be held at Convention Hall, Atlantic City, N. J. Further information is available from institute headquarters, 1346 Connecticut Ave., N.W., Washington, D. C.

Nov. 2-6—

American Society for Metals. National Metal Exposition and Congress to be held at the International Amphitheatre, Chicago. Further information is available from ASM headquarters, Metals Park, Novelty, Ohio.

Nov. 3-5—

Mid-America Electronics Conference to be held at the Municipal Auditorium, Kansas City, Mo. Additional information can be obtained from Ira J. Jones, Bendix Aviation Corp., P. O. Box 1159, Kansas City 41, Mo.

Nov. 4-6—

American Nuclear Society. Winter Meeting to be held at the Sheraton Park Hotel, Washington, D. C. Further information can be obtained from society headquarters, 86 E. Randolph St., Chicago 1, Ill.

MOTOR CONTROLS

New NEW WEATHERPROOF and EXPLOSIONPROOF ENCLOSURES WEIGH ONE-HALF AS MUCH AS CONVENTIONAL BOXES

Offering Weatherproof and Explosionproof enclosures of strong, cast aluminum, *one-half the weight of old-style cast iron boxes.* Choice of fused or unfused Disconnect Switch or Circuit Breakers.

ENCLOSURES FOR EVERY USE:

- General Purpose – NEMA TYPE 1
- Weatherproof – NEMA TYPE 4
- Explosionproof – NEMA TYPES 7 and 9
- Industrial (oiltight and dust resistant) – NEMA TYPE 12

AVAILABLE:

- Non-Reversing, Reversing and Two-Speed Types
- In NEMA SIZES 0 through 4
- Front operated by means of Fused or Unfused Disconnect or Circuit Breaker. Circuit Breakers are Instantaneous or Thermal Magnetic Trip Types.
- With or Without Control Circuit Transformers

"RIGHT ANGLE" DESIGN STARTERS:

- Straight-Thru Front Wiring • Epoxy-Resin Encased Coils
- Large, Long-Life Contacts • Easy Maintenance Proved Dependability

Write today for engineering details on Arrow-Hart's complete lines of Combination Starters to: The Arrow-Hart & Hegeman Electric Co., Dept. MD, 103 Hawthorn St., Hartford 6, Conn.

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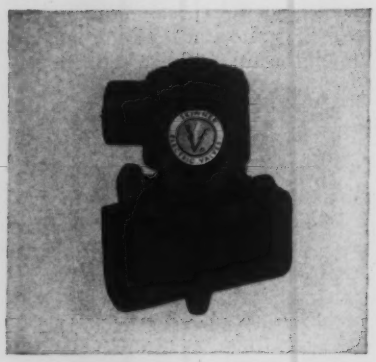
Quality since 1890

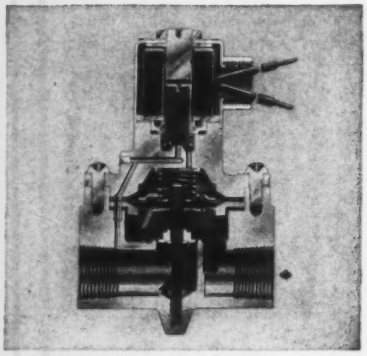
MOTOR CONTROLS • ENCLOSED SWITCHES • APPLIANCE SWITCHES • WIRING DEVICES

Circle 425 on Page 19

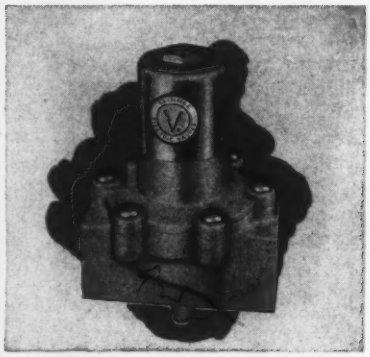
Skinner 2-way Solenoid Valves provide High Flow at Low Cost



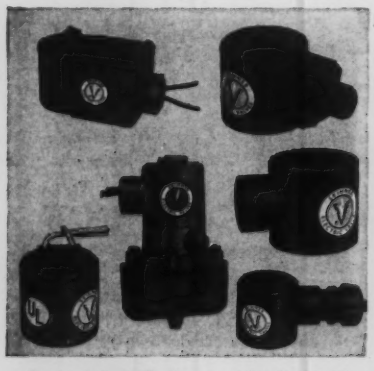
Unusually low-cost model... the LC2 valve. A small, light, normally closed valve. Permits full flow through 1/2" orifice with 3/8" or 1/2" NPT ports. Will control all common media: air, oil, water, etc. Handles pressures from 5 psi to 150 psi, with temperature ranges from minus 40°F to plus 180°F, and will operate on all popular AC and DC voltages.



Features of L Series valves. Like all Skinner valves, these are built to UL standards. Their bodies are made of forged naval brass and their internal parts are stainless steel and brass. Soft, synthetic inserts and seals provide bubbletight operation. And a unique, Buna-N coated nylon diaphragm assembly assures long life. They mount in any position directly to the line. A variety of coils for common AC and DC voltages is available.

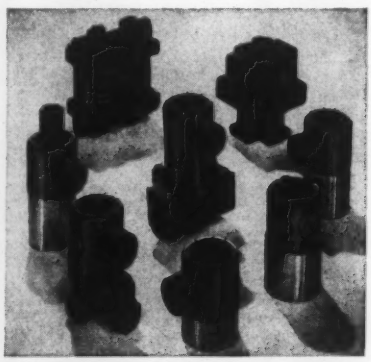


Full extent of line includes L2 models featuring 1/2" orifice with 3/8" or 1/2" NPT ports, 3/4" and 1" orifices with 3/4" and 1" NPT ports. At greatly reduced cost, these valves permit applications not possible before. They are available normally open or normally closed in standard or explosion-proof construction.



Custom installation can be had with these options. There is a large selection of electrical housings that can be rotated 360° for easy connecting. Also available for these L2 valves is manual override that permits opening or closing of the valve in the event of a current failure.

For quickest service, write for Skinner's Nationwide Stock List. It covers all of the valves universally stocked by Skinner distributors and includes a number of the L Series valves. From this list, your local Skinner distributor can quickly meet your requirements.



A complete line. There's a Skinner solenoid valve for almost any flow application with a wide variety of media: air, oil, water, inert gases, hydraulic fluids, kerosene and gasoline. Orifice sizes range from 3/64" to 1". Pressure ratings range from vacuum to 3000 psi. Explosion-proof models are UL approved for Class 1, Group D and Class 2, Groups F and G.

Skinner solenoid valves are distributed nationally.

For complete information, contact a Skinner Representative listed in the Yellow Pages or write us at Dept. 420.

SKINNER ELECTRIC VALVES

THE CREST OF QUALITY **THE SKINNER ELECTRIC VALVE DIVISION • NEW BRITAIN, CONNECTICUT**

"LFN" SERIES

"Dyflon"®

Self-Aligning and Self-Lubricating SPHERICAL BEARINGS

Combine "Monoball"® Engineering Advantages with Life-Time Lubrication

ROD END INTERNAL THREAD TYPE "DREF" SERIES

Design engineers in many industries are specifying new "DYFLON"® SELF-ALIGNING and SELF-LUBRICATING SPHERICAL BEARINGS for these 5 major reasons:

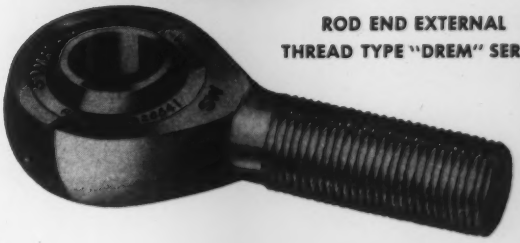
1. LOWER COEFFICIENT OF FRICTION ... ideal where lubrication is impossible or undesirable.

2. WITHSTAND EXTREME VIBRATION ... perfect performance under shock load conditions.

3. WILL NOT "COLD-FLOW" ... even under extreme load conditions.

4. IMPERVIOUS TO KNOWN CHEMICAL SOLVENTS ... eliminates corrosion problems.

5. FAIL SAFE ... due to "Monoball"® design.



ROD END EXTERNAL THREAD TYPE "DREM" SERIES

"LF" SERIES

In addition, due to their two-piece "MONOBALL"® design and plastic alloy insert, "DYFLON"® bearings have a long cycle life. Alignment and installation problems are minimized. Oil-free for life means lowest possible maintenance costs.

Available in a variety of plain or rod end types. Bore sizes to 3.000". Materials include stainless steel, plastic alloys and chrome alloy steels. Ultimate static loads to 500,000 lbs.

Engineered to the same high standards as Southwest's popular "MONOBALL"® Self-Aligning Bearings.

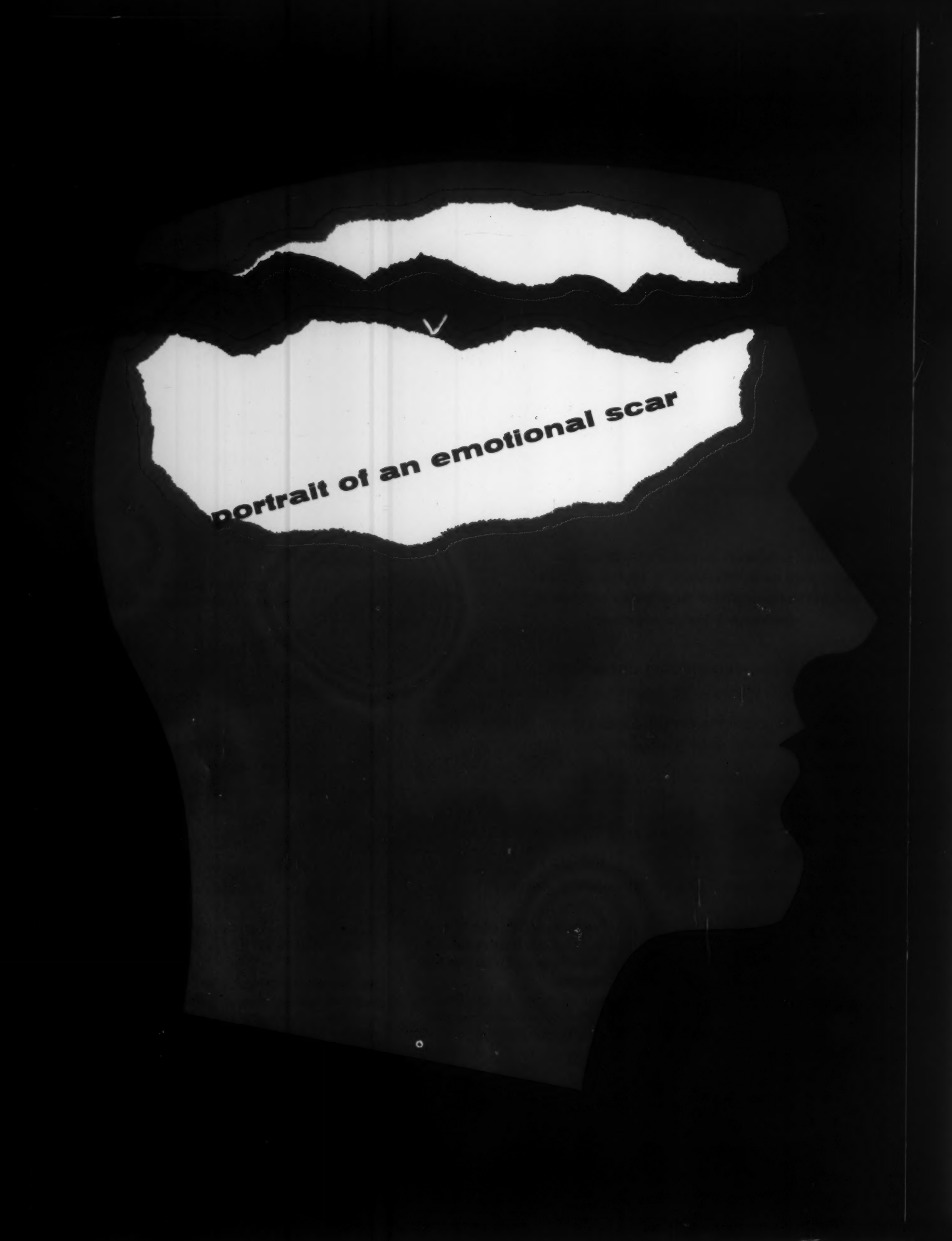
SOUTHWEST "DYFLON"® "Monoball"® bearings can solve your difficult alignment and installation problems. Request Engineering manual No. 551.

SOUTHWEST PRODUCTS CO. RELIABLE PRODUCTS

SOUTHWEST PRODUCTS CO.

1705 SO. MOUNTAIN AVE. • MONROVIA, CALIF. • PHONE: MURRAY 1-9616

Circle 427 on Page 19


portrait of an emotional scar

How can you depict the shock, anger and disappointment that really takes place when it happens? How does *anybody* know how it feels to see a die crack during the last few minutes of heat treating? How can anybody know, except the man responsible for purchasing the original piece of steel?

What went wrong? Heat treating procedures checked out O.K. And it *should have* been a good piece of steel. It came from a reliable mill that uses all the standard methods of specialty steelmaking and applies all the normal quality controls. Furthermore, tool and die steel from the same mill had been satisfactory on other jobs.

Predictable performance . . . no predicaments. *Carpenter's revolutionary new* MEL-TROL® *process* is not a standard method for making specialty steels. It's exclusive. It utilizes a new patented mold which reduces segregation of harmful impurities during solidification of the ingot. This ingot is far more uniform. You get steel which is cleaner, sounder, tougher from surface to center . . . in every bar . . . in every lot. It takes the guesswork out of toolmaking, because you know *in advance* what results you will get.

Avoid emotional scars. Next time order Tool and Die Steels from your nearby *Carpenter* SERVICE-CENTER. You'll look better in the eyes of your Company.

Carpenter steel

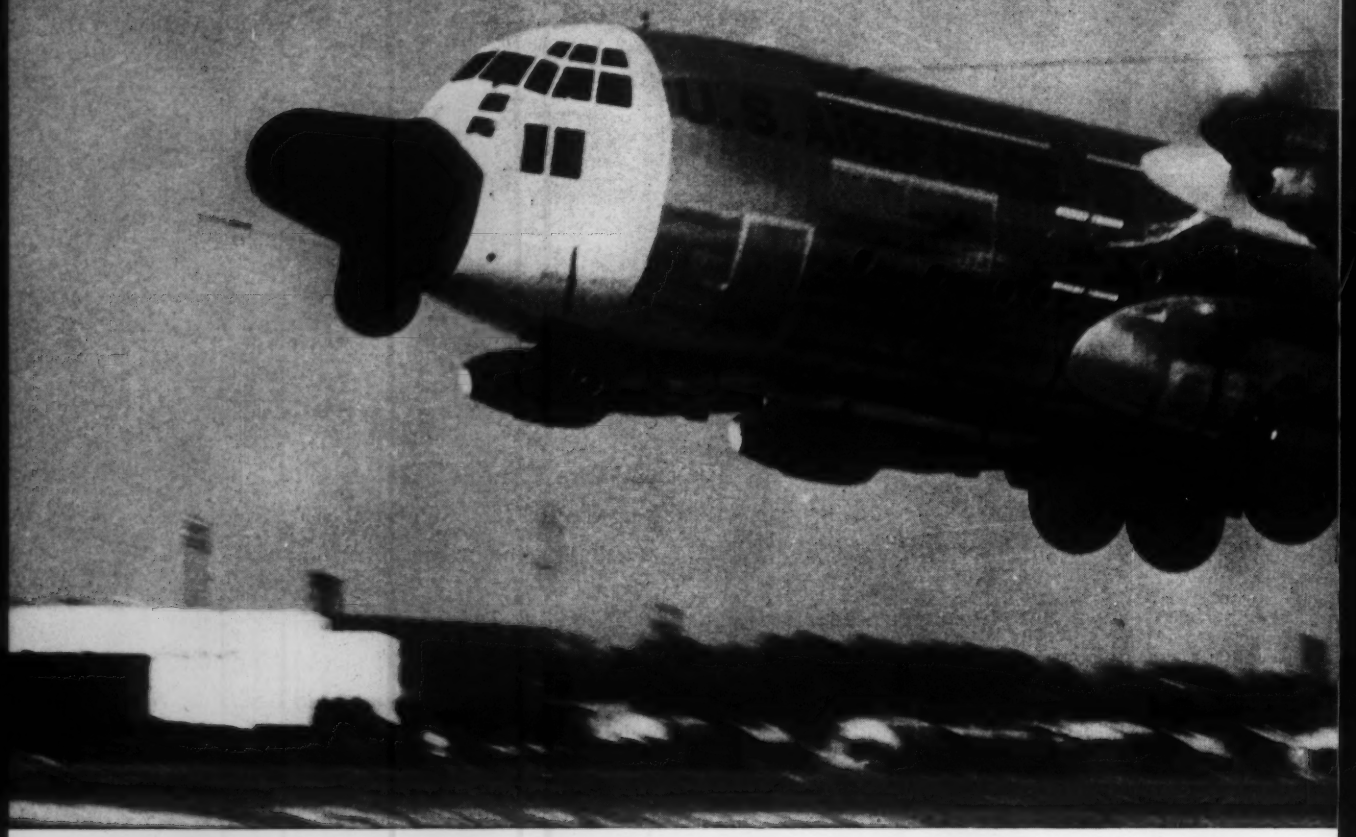
tool and die steels
stainless steels
electronic, magnetic and electrical alloys
high temperature alloys
special-purpose steels
tubing and pipe
fine wire specialties

a new company 70 years old

The Carpenter Steel Company, Main Office and Mills, Reading, Pa.
Alloy Tube Division, Union, N. J.
Webb Wire Division, New Brunswick, N. J.
Carpenter Steel of New England, Inc., Bridgeport, Conn.

Circle 428 on Page 19

370 mph prop-jet Hercules combat transport starting on target drone launching mission. It will cruise at 30,000 ft. Special radar and launching gear permit Hercules to fire, monitor and aid recovery of drones in tests of ground and air defense systems. *Photo courtesy Lockheed.*



R/M friction piece prolongs landing

Designers of Lockheed's C-130 Hercules, prop-jet assault transport, required a friction material which would help prolong the life of the landing gear guide track. Its use was to face aluminum shoes attached to four main shock struts.

Rigorous tests

Specifications called for a friction material of relatively high bearing strength to withstand ground load stresses of up to 18,000 psi and stable coefficient of friction within a narrow range required to operate against the aluminum track which it would contact.

A wide variety of metal and organic friction materials were subjected to rigorous tests at temperatures to −65°F, in such contaminants or abrasives as mud, dust, tar and ice. The material proved most satisfactory was R/M sintered bronze brazed onto a .010-in.-thick strip of mild steel, a product of Raybestos-Manhattan ingenuity.

A structural adhesive bonds the material to an aluminum shoe at 70 psi with a curing cycle of 1 hour at 350°F. In inspection tests, the bond must show a peel strength of not less than 50 lb. per inch of width.

The aluminum shoe assemblies, faced with the R/M materials, are mounted on air-oil shock struts which serve to support the aircraft on the ground, absorb landing shocks.

Satisfactory performance

Lockheed engineers report that the R/M material has been used in every production model of the C-130 and has delivered

R/M
FIRST IN FRICTION

RAYBESTOS-MANHATTAN, INC.

EQUIPMENT SALES DIVISION: Bridgeport, Conn. • Chicago 31 • Cleveland 16 • Detroit 2 • Los Angeles 58

RAYBESTOS-MANHATTAN, INC., Brake Linings • Brake Blocks • Clutch Facings • Sintered Metal Products Industrial Adhesives • Mechanical Packings • Asbestos Textiles • Industrial Rubber • Rubber Covered Equipment • Engineered Plastics • Abrasive and Diamond Wheels • Laundry Pads and Covers • Bowling Balls

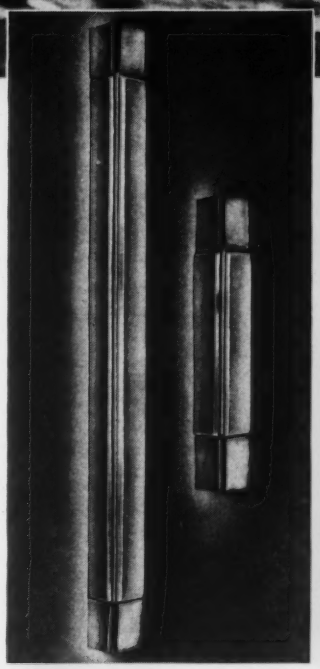
gear life !

satisfactory performance in this exacting application . . . not one report of excessive wear!

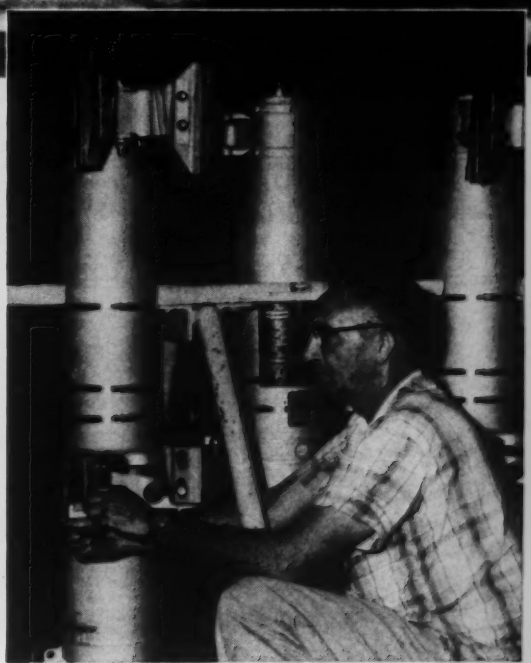
This is another example of the diversity of successful applications of Raybestos-Manhattan friction materials. Why not let R/M's experienced engineers help you solve your friction problems . . . you can always be sure of sound, unbiased counsel on the materials best suited to a given application—for *only R/M manufactures all types of friction materials!* An R/M sales engineer can be at your desk within 24 hours.

Send now for your free copy of Bulletin No. 501 —packed with helpful engineering information on friction materials.

Circle 431 on Page 19



R/M sintered bronze brazed onto .010-in.-thick strips of ½-in.-wide mild steel from these 8¼- and 3-in.-long friction pieces for the Hercules.



Lockheed technician completes installation of landing gear guide shoes onto main shock struts. 16 shoes, each faced with ½-in.-wide sintered metal strip, are used in every production model of the C-130.

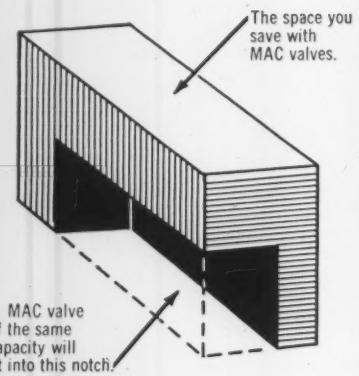
Cuts Air-Valve Size 67% with New Design

Also Boosts Performance, Life, and Ease of Service

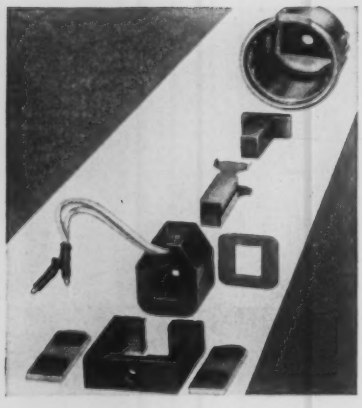
A remarkable new line of pilot-operated air-valves—the MAC series 300—cuts space requirements to ⅓ of that normally required for valves of equal capacity rating.

Not only is the valve extremely simple in operation, reducing cost, but the three moving parts can be replaced in a matter of 1 to 2 minutes without special tools. Life of moving parts is rated at 30,000,000 cycles, minimum.

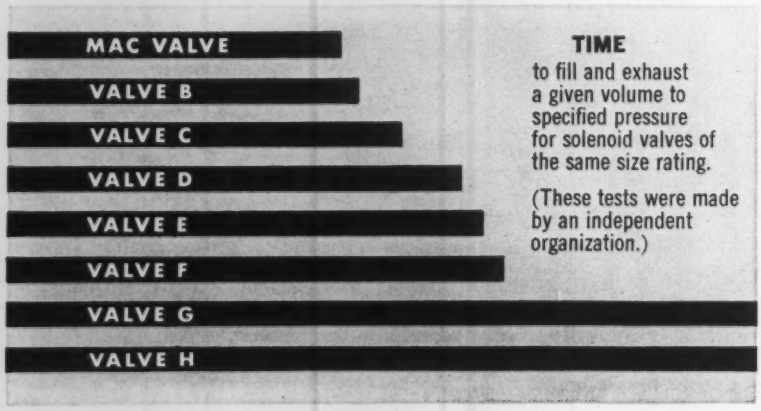
The story of how this was accomplished, together with valve sizes and specifications, is contained in Bulletin #300A available from Mechanical Air Controls on request.



New Solenoid Boosts Valve Life —Virtually Foolproof, it also has Lighter Draw



A virtually failure proof solenoid which can be completely assembled or taken apart without any tools—but which can't be assembled wrong has been developed by Mechanical Air Controls. It has no welds to break or crack. It has no screws, nuts, bolts or other fasteners to work loose. It has a fully encapsulated water and oil resistant coil. There is no wiring through air valve body. The connections just plug in. The entire assembly floats on rubber mounts, the rubber being in shear. The solenoid has a lower draw because of the lighter push required. The design provides for both locking and manual jogging. It is standard on every MAC series 300 air valve.



TIME
to fill and exhaust a given volume to specified pressure for solenoid valves of the same size rating.

(These tests were made by an independent organization.)

advances in PNEUMATICS

MAC

designing an air valve . . .

There are two ways to design air-valves. One is for a specific job, and no more. For example, a valve in a missile usually has to function only once. Wear life is no problem. The other way is to design a valve for the *toughest* job it might face and then use it on easier jobs, too.

Any engineer would prefer the second way, but he wonders "Won't it cost too much?"; or "Won't I be criticized for providing more performance or life than needed?"

His worries are pointless. The second way doesn't have to cost more. Extra performance and quality can be a free "plus." If you design air-valves for the TOUGHEST jobs they can encounter (as we did at MAC) you can naturally get a simpler, more compact, easier-to-service valve; plus extra performance reserve—all AT LOWER COST.

Why? Once the valve licked the toughest application—where speed, reliability, serviceability and life were MOST vital—we simply standardized for mass production. That's how we wound up with a better and lower cost valve . . . the series 300.

President

MAC

MECHANICAL AIR CONTROLS, INC.
10030 Capital, Oak Park • Detroit 37, Michigan

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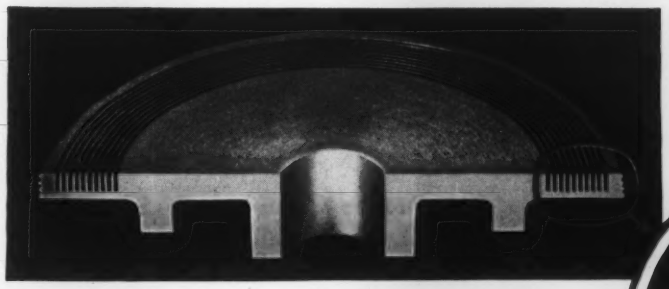
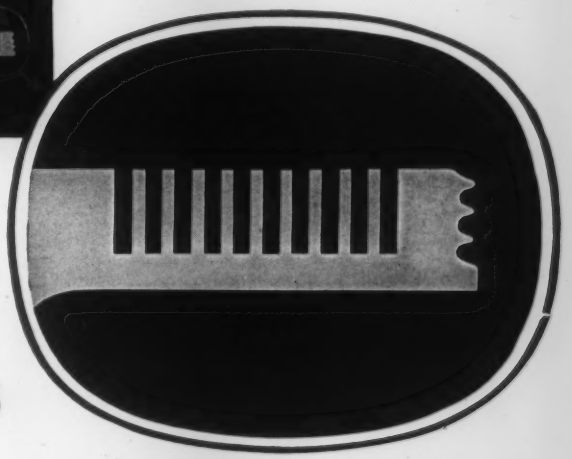
Do Your Castings Require Sharp Corners *Like These?*





The Denser Structure of EATON PERMANENT MOLD GRAY IRON CASTINGS

Permits the Machining of Precise Corners

The fine dispersion of graphite in Eaton Permanent Mold Iron and its dense, non-porous, homogeneous structure make it an ideal material for many difficult machining operations where accurate dimensional results and sharp corners are essential.

Because its superior structure permits the machining of extremely thin sections and has the ability to take a high surface finish, Eaton Permanent Mold Iron is recommended for such critical applications as bearing retainers, connecting rods, pulleys, carburetor bodies, valve bodies, and service valves.

If you have applications which require these exceptional characteristics, our engineers will be happy to work with you.

The part shown above required that 10 grooves, .023" wide and .125" deep, leaving 9 lands .015" wide, be rapidly and simultaneously machined. Eaton Permanent Mold Iron proved to be the ideal material—completely eliminating the problem of curling chips in the small grooves, and crumbling of lands during machining.

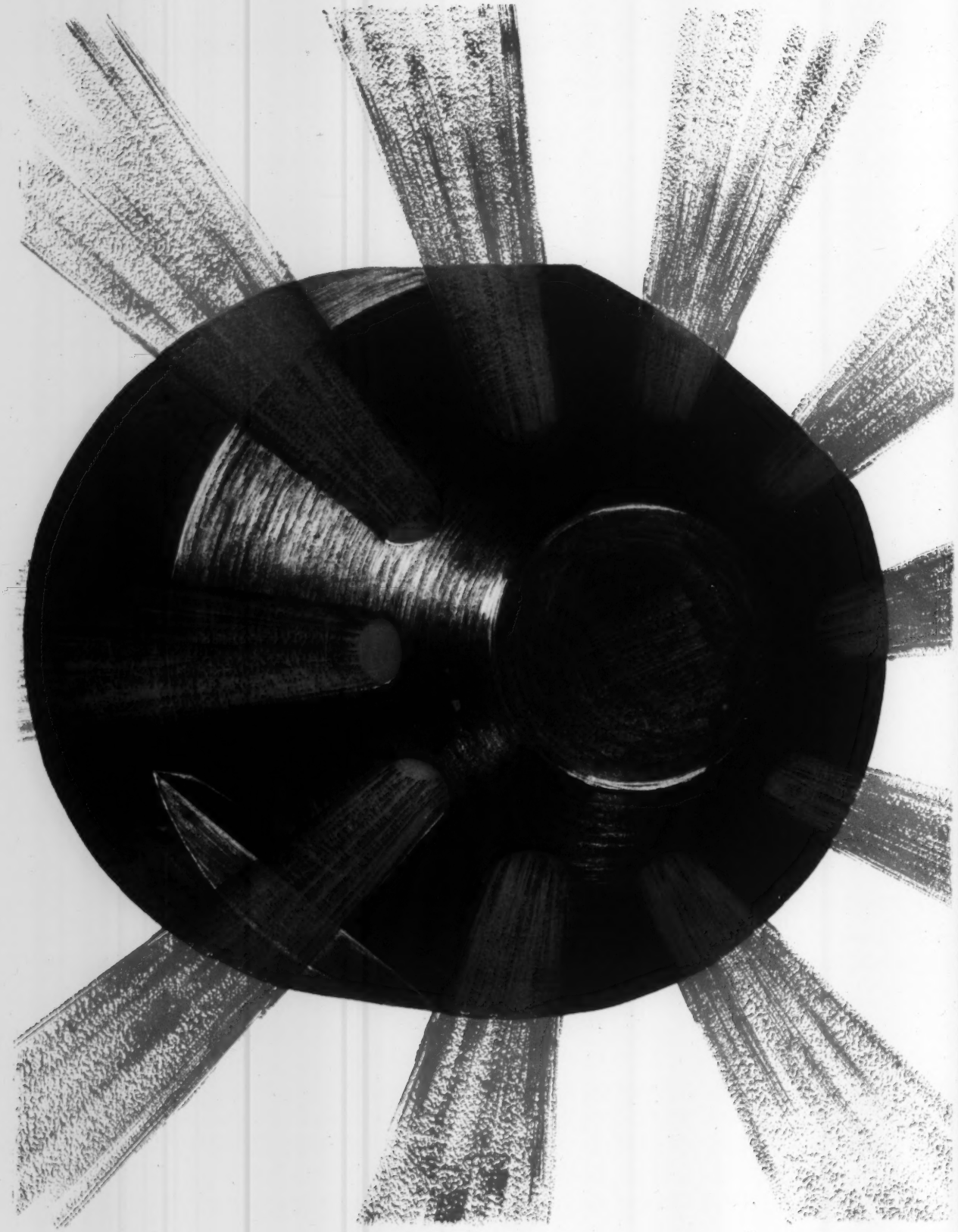
Check these Important Advantages:

- ★ **Dense, non-porous, homogeneous structure**
- ★ **Freedom from inclusions**
- ★ **Excellent tensile strength**
- ★ **Ability to take a high surface finish**
- ★ **Freedom from leakage under pressure**
- ★ **Intricately cored sections**
- ☆ **Uniformity of castings**
- ★ **Higher machining feeds and speeds**
- ★ **Substantially increased tool life**

Send for Illustrated Descriptive Literature

EATON — FOUNDRY DIVISION — MANUFACTURING COMPANY
VASSAR, MICHIGAN

PRODUCTS: Engine Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Jet Engine Parts • Hydraulic Pumps • Motor Truck Axles • Permanent Mold Gray Iron Castings • Forgings • Heater-Defroster Units • Automotive Air Conditioning Fastening Devices • Cold Drawn Steel • Stampings • Gears • Leaf and Coil Springs • Dynamatic Drives, Brakes, Dynamometers



FOR THE MACHINERY PART THAT TAKES THE BEATING

Critically contoured holes in burner nozzles made of high alloy steel . . . distorted in two days. Mild steel corroded in two hours. But HASTELLOY alloy B nozzles now last several months . . . despite the punishing, high-velocity flow of steam-atomized fuel oils containing sulphuric acid, sulphur compounds, and other corrosive agents.

It's just one more example of why thousands of design and production engineers looking for tough metals for machinery parts . . . specify HAYNES alloys.

If design and production in your field demand really tough metal parts, look into HAYNES alloys. There are more than 15 to choose from, including HAYNES STELLITE cobalt-base alloys, HAYNES iron-base alloys, HAYSTELLITE cast tungsten carbide, and HASTELLOY nickel-base alloys. They are available as castings, forgings, completely fabricated parts, or as sheet and bar stock. All parts can be furnished machined or ground to specified size and finish.

HAYNES Alloys *will do the job!*

HAYNES ALLOYS

HAYNES STELLITE COMPANY

Division of Union Carbide Corporation
Kokomo, Indiana

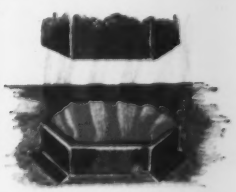
UNION CARBIDE

Address inquiries to Haynes Stellite Company, 420 Lexington Avenue, New York 17, N. Y.

The terms "Haynes," "Haynes Stellite," "Hastelloy," "Haystellite," and "Union Carbide" are registered trade-marks of Union Carbide Corporation

TYPICAL MACHINE PARTS OF ABRASION-RESISTANT "HAYNES" ALLOYS

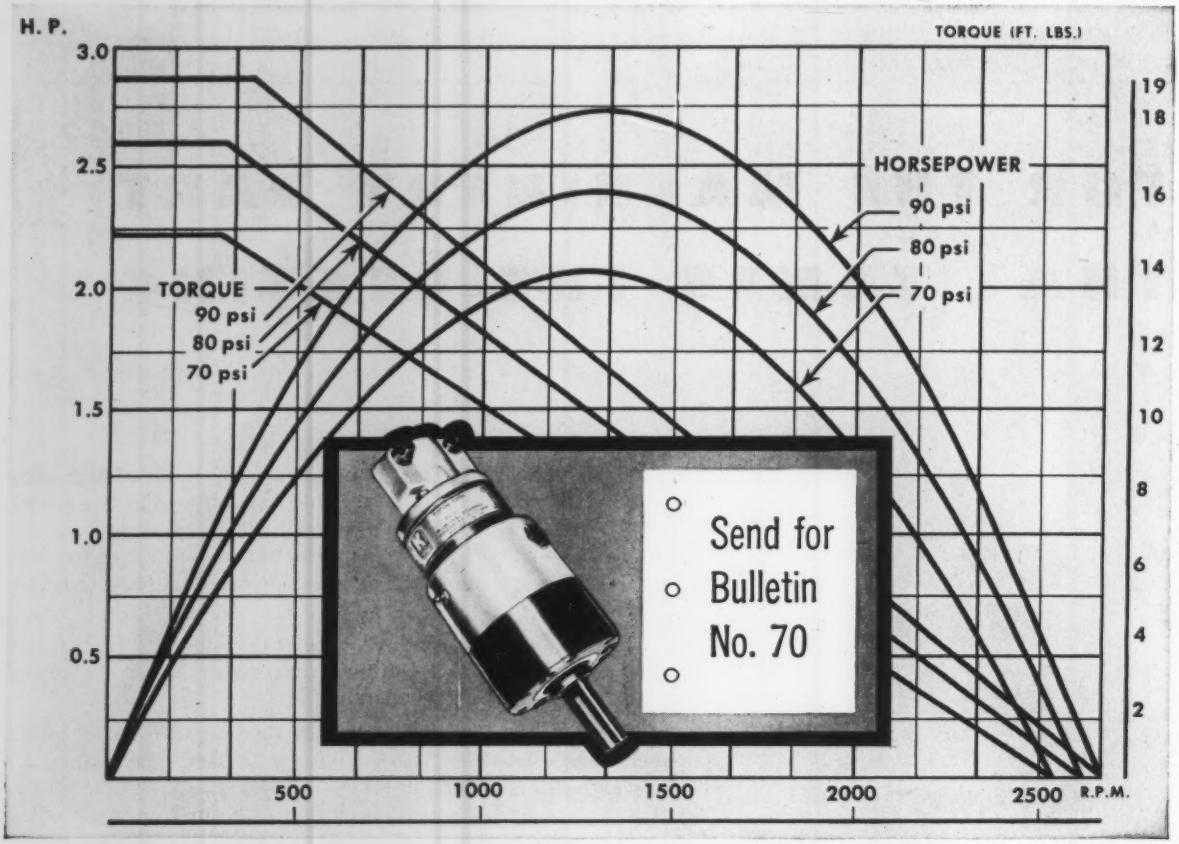
MILK BOTTLE CAPPER sealing-segment fingers, investment cast of HAYNES STELLITE alloy No. 6, capped 100-million bottles in five years without noticeable wear.



DIE LINERS cast from HAYNES 93 alloy have worn only 0.015 in. while making 20,000 bricks from highly abrasive materials, far outlasting other metals.

HALF BUSHINGS made of HAYNES STELLITE alloy No. 6B are used as can headers of a machine that makes 300 milk cans a minute.

Circle 434 on Page 19



Typical performance curves for one size of Gardner-Denver axial piston air motors.

Efficient operation at high or low pressure . . . Gardner-Denver axial piston air motor

WHEN YOU NEED A "SPECIAL"

. . . talk to the Gardner-Denver man—a specialist himself. He can help you design applications, special mountings, special controls. He'll see that your "special" is quality-engineered by experienced Gardner-Denver men, for there's no substitute for men—our 100-year philosophy of growth.

Here's a rugged, compact axial piston air motor from Gardner-Denver that operates efficiently whether air pressure is high or low. Therefore, it can be applied to low-speed, high-speed or infinitely variable speed drives—simply by regulating air supply. Sizes from 0.6 to 2.7 hp, with free speeds from 450 to 4800 rpm, stall torques to 110 ft.-lb.

Compact design permits use in places where space is limited. Stout spindle, tough bearings and rugged case give this air motor the ability to carry an overhung load as great as 1000 lb. with no external support. Rugged construction and precision parts insure maximum service with minimum maintenance. Can be mounted in any position.

This Gardner-Denver air motor also features instant starts and stops, reversible operation and no spark hazard. It works in heat, moisture or dust . . . can't burn out. Can air power help *your* design? For complete information, contact your nearby Gardner-Denver representative or write for Bulletin 70-1.

GARDNER-DENVER Since 1859

100 1959 YEARS

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois

In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Avenue, Toronto 16, Ontario

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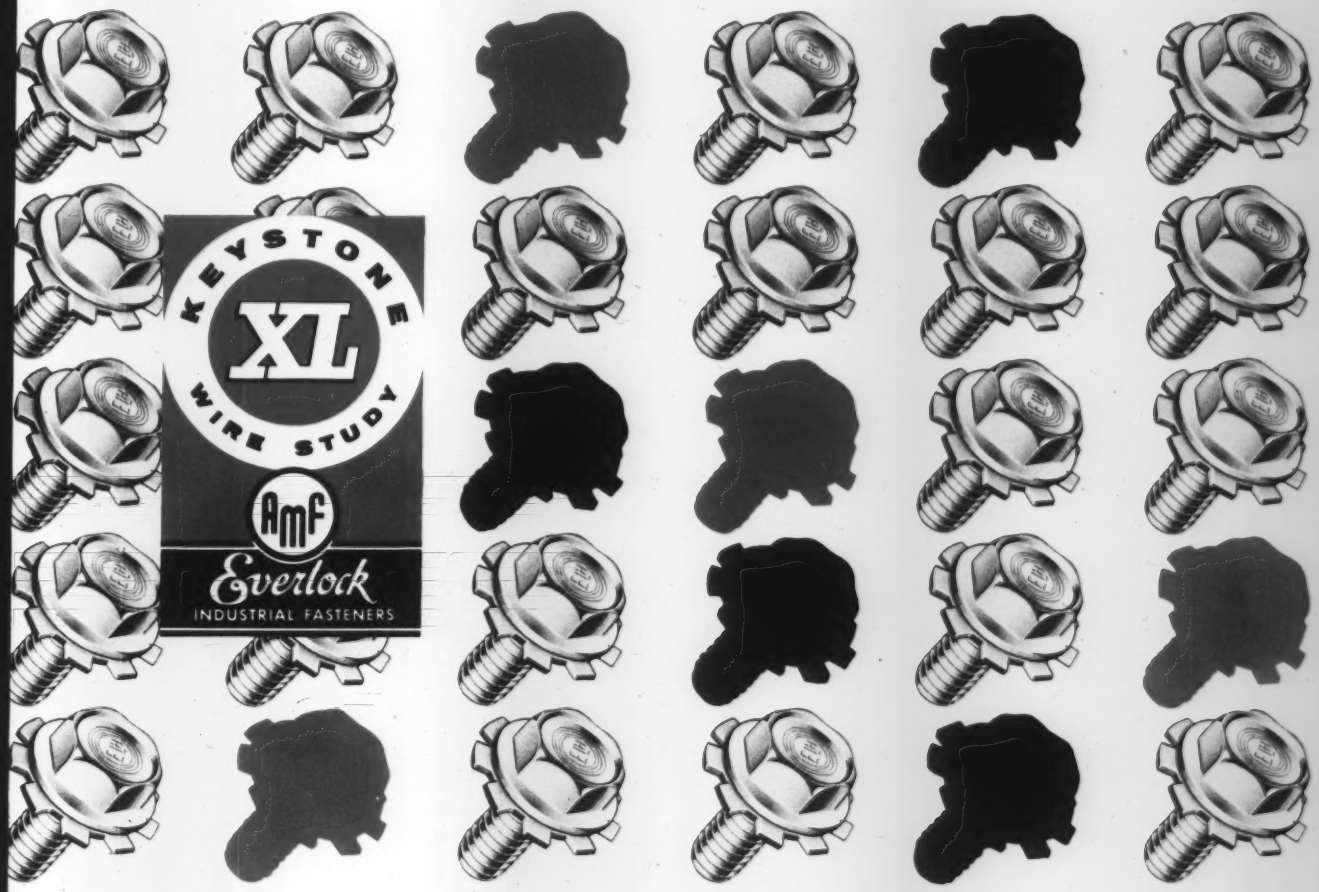
Circle 436 on Page 19→



KEYSTONE XL *flowability* is the secret of volume production at Thompson-Bremer & Co.

DIVISION OF AMERICAN MACHINE & FOUNDRY CO.

Users of Sems fasteners recognize this familiar symbol as the Everlock trademark of Thompson-Bremer & Co. division of American Machine & Foundry Co., Chicago, Illinois. Using Keystone XL Wire, head cracking is eliminated and die life increased 30%. They manufacture many fasteners in two blows including this 5 diameter Sems, or this Phillips hex screw with a 4½ diameter head and extruded pilot point. Keystone and Thompson-Bremer worked together to develop just the right wire to produce a better quality product at a competitive cost. Confidential counseling and metallurgical assistance is yours for the asking, too! Call us.

Keystone Steel & Wire Company, Peoria 7, Illinois

KEYSTONE
WIRE FOR INDUSTRY

The broad effect of CLAD-REX® on industrial design, engineering, and selection of materials

Reaction to the potential offered by vinyl-clad metals is contradictory. The potential advantage is so broad that it's hard to believe. But, when full realization does begin to develop, enthusiasm tends to go too far!

Therefore, your vinyl-clad metals data file should be assembled with care. Know exactly what you are considering, when to use it, and how.

Clad-Rex is a vinyl-metal laminate. Specifically, a calendered, semi-rigid poly-vinyl chloride film bonded to sheet metal. All alloys and tempers of aluminum and steel (including galvanized and aluminized) are commonly used. However, other metals can be used where their special properties are important to end product performance.

The sales appeal of Clad-Rex vinyl-metal laminate

The words *calendered* and *film* mean styling in Clad-Rex is unlimited, because film can be printed. Simulated wood-grains and leathers, as well as any color, combination of colors, texture or pattern can be used. Or you can design your own, if you prefer.

This unlimited choice ranges from sparkling burnishes including high metallics, to non-reflective matte finishes (or variations between) as well.

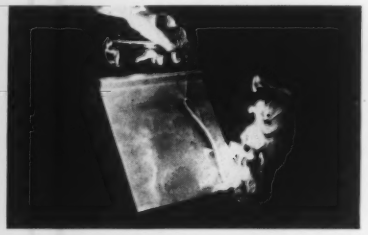
The abrasion resistance of Clad-Rex vinyl-metal laminates

The words *semi-rigid* and *poly-vinyl chloride film* mean Clad-Rex has unusual resistance to abrasion. Therefore, products made of Clad-Rex are more durable and suited to usage where abrasion resistance is required.

However—most important to manufacturing—Clad-Rex can be processed without the careful handling or rejects common to other pre-finished metals.

The corrosion resistance of Clad-Rex vinyl-metal laminates

The words *poly-vinyl* and *chloride* become important again, because of the inherent properties of the Clad-Rex vinyl. It provides excellent resistance

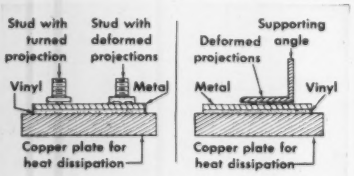


to acids and alkalis, as well as other corrosive chemicals. It also has high dielectric properties.

The fabrication of Clad-Rex vinyl-metal laminates

Clad-Rex can be formed in almost as many ways as any *un*finished sheet metal—including deep drawing!

Resistance welding, generally, is limited to projection techniques. However, the equipment must be (1) tooled for series welding (both electrodes on same side of sheet), and (2) capable of very short weld times with extremely fast follow-up of forging pressure.



Epoxy resins are proving quite successful for assembly. Clamps can be eliminated by using resistance weld tacking or interlocking design.

The cost advantage of Clad-Rex vinyl-metal laminates

As a purchased material going into a user's plant, vinyl-metal laminates cost more than *un*finished or some other pre-finished metals. *But, most important, end products made of Clad-Rex generally cost less!* Here's why:

(1) Parts made of Clad-Rex require no further finishing. This is a savings in equipment, finishing material, factory floor space, labor, handling, etc.

(2) The abrasion resistance of Clad-Rex substantially reduces (and often eliminates) rejects. This includes both rejected products *and* the expensive handling, reworking activities, and labor required.

Movement of sub-assemblies, etc., through your plant actually becomes more direct—out of your dies into assembly!

A source of engineering and manufacturing service for you

Clad-Rex interest in helping you extends into your own plant. A Clad-Rex Fabricating Engineer is provided to show your production people how easy it is to process Clad-Rex.

Furthermore, Clad-Rex operates a fully staffed and equipped research laboratory. Its facilities are devoted to customer service as well as improving Clad-Rex itself.

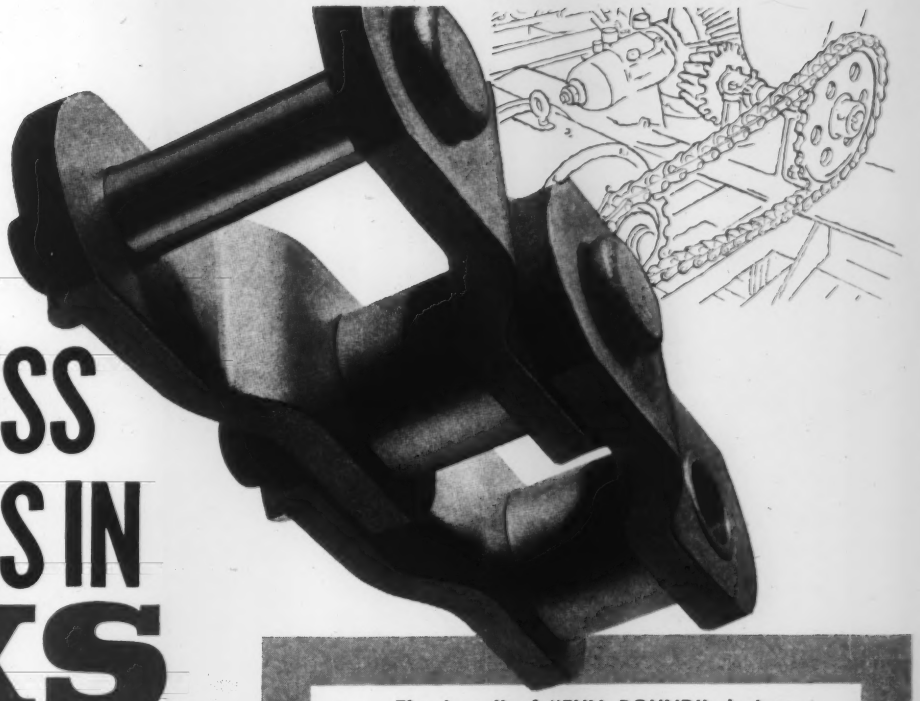
Write and describe your product. See how Clad-Rex can work its broad effect on industrial design, engineering and selection of pre-finished metals in your product.

VINYL-METAL LAMINATES BY CLAD-REX DIVISION OF SIMONIZ COMPANY

2113 Indiana Avenue • Chicago 16, Illinois

Telephone: VIctory 2-7272

4-BR



FAR LESS STRESS IN LXS

THE CHAIN WITH NO "STRESS RAISERS"! Link-Belt LXS brings long-term economy and efficiency to the most punishing drive and conveying jobs. With its "FULL-ROUND" design, LXS has no stress concentration points . . . none of the sharp corners which frequently shorten the life of many ordinary chains.

LXS is available with straight or offset sidebars. For details, contact your nearest Link-Belt office. (See CHAINS in the yellow pages of your phone book.) Ask for our new, comprehensive Catalog 1050.

They're all of "FULL-ROUND" design

PINS BUSHINGS SIDEBARS

"FULL-ROUND" design eliminates traditional stress concentration points in Link-Belt LXS . . . provides maximum live bearing area between pins and bushings. Result: stress is distributed evenly.

Other LXS long-life features include controlled press fits plus use of selected steels and controlled hardening of all parts. All this contributes to greater uniformity, greater endurance.

LINK-BELT

CHAINS AND SPROCKETS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World. 15,082

FOR TOP
PERFORMANCE
EVERY TIME

ONLY RAMCO MAKES BOTH TYPES OF MODERN RETAINING RINGS

***Retaining Rings by* THOMPSON PRODUCTS**

another product of ***Thompson Ramo Wooldridge Inc.***

PERFORMANCE? ASSEMBLED COST? APPEARANCE?

WHAT IS YOUR MAJOR FASTENER PROBLEM?

If it is performance, Ramco retaining rings will give you the one best answer!

SpirOlox

A time-tested Ramco design; full-circle 360 degree retaining ring opens up unlimited possibilities for improved design and economies in thousands of new or present products.

- √ Uniform wall allows installation with minimum clearance.
- √ Two turn, full-circle design eliminates gaps.
- √ No special tools needed for installation or removal.
- √ No tooling needed for prototypes—complete design flexibility.
- √ Develops a unique "friction lock" under load.
- √ Always uniform in quality.
- √ Special designs for high speeds or tolerance stack-up problems.

CircOlox

The answer to easy, lightweight, low cost assemblies and reduced manufacturing costs. Made in a variety of types and sizes for the smaller shaft or housing diameters.

- √ "Deep-groove" design permits maximum thrust with minimum weight.
- √ Easily installed or removed.
- √ Available in a variety of materials.
- √ Wide choice of finishes.
- √ Always uniform in quality.
- √ Meets Government and Industry Standards.

Only Ramco makes both types of modern retaining rings . . . both engineered for peak performance . . . ample safety for thrust load . . . rings that won't be sloppy in the groove . . . that can't jump out . . . that are dependable, dynamically balanced and made in a wide range of designs, styles, materials and finishes.

You're further assured of top performance because Ramco Rings are manufactured in the world's most modern ring plant . . . designed to the highest engineering standards established by Thompson Products and Ramco . . . the same engineering skill that serves the nation's car factories, aircraft builders, missile and electronic manufacturers.

Send us a blueprint of your toughest retaining ring problem. We'll send you the one best answer to your problems of increasing performance, cutting assembled cost, or improving appearance. A special Retaining Ring engineering Catalog and Price Lists are yours without cost or obligation. Why not mail the coupon today for your copies?

Thompson Products Ramco Division
Box 513, Dept. B, St. Louis 66, Mo.
Send latest Engineering and Price Catalogs of Spirolox and Circolox Retaining Rings.

Name.....Title.....

Company.....

Address.....

City.....Zone.....State.....

Samples Wanted: Spirolox ☐ Circolox ☐ Size.....

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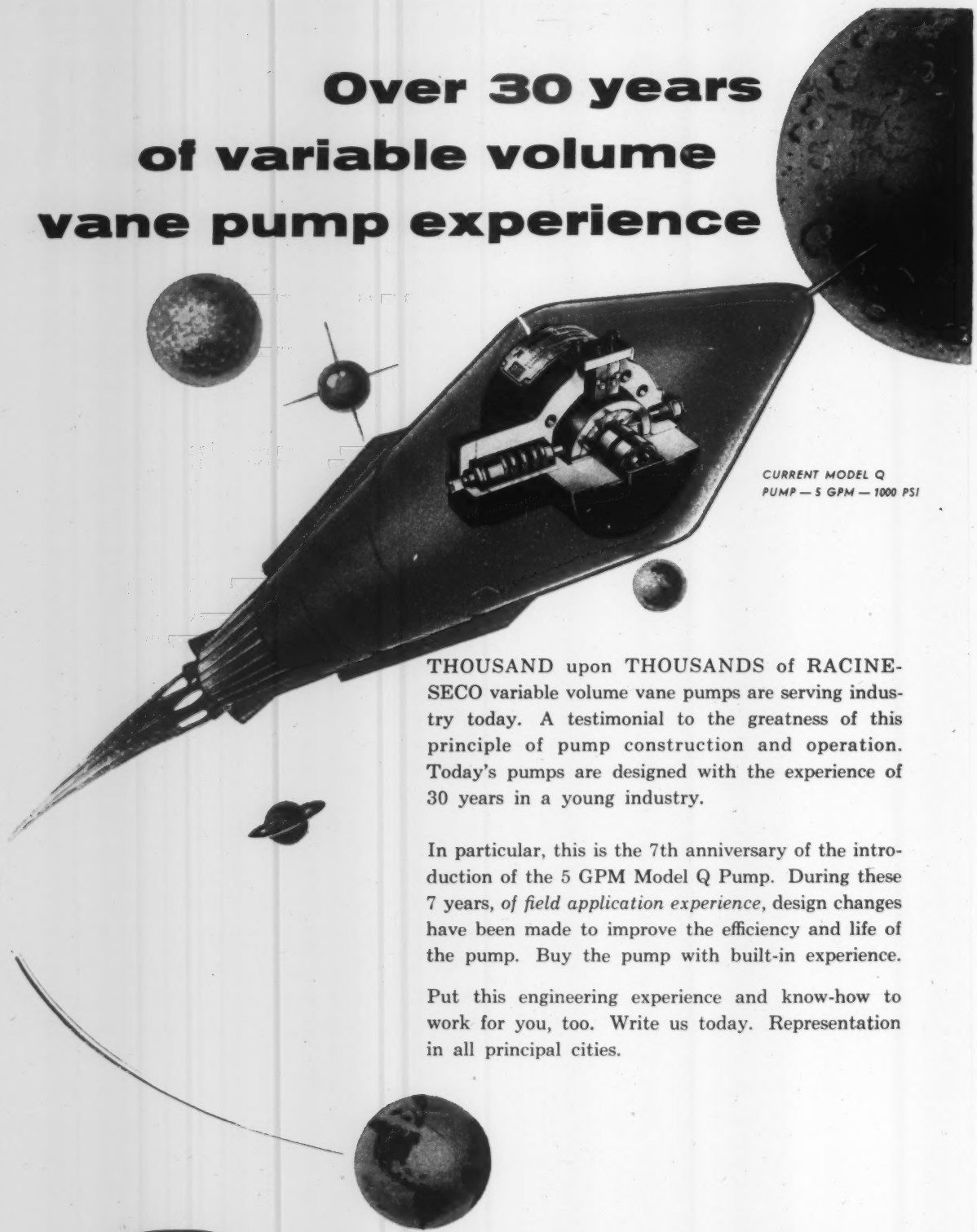
RAMCO DIVISION

automotive group

TRW

Our credo for serving America's giant manufacturing industry is simply stated . . . "Give the GENTLEMAN what he wants."

Over 30 years of variable volume vane pump experience



CURRENT MODEL Q
PUMP — 5 GPM — 1000 PSI

THOUSAND upon THOUSANDS of RACINE-SECO variable volume vane pumps are serving industry today. A testimonial to the greatness of this principle of pump construction and operation. Today's pumps are designed with the experience of 30 years in a young industry.

In particular, this is the 7th anniversary of the introduction of the 5 GPM Model Q Pump. During these 7 years, *of field application experience*, design changes have been made to improve the efficiency and life of the pump. Buy the pump with built-in experience.

Put this engineering experience and know-how to work for you, too. Write us today. Representation in all principal cities.

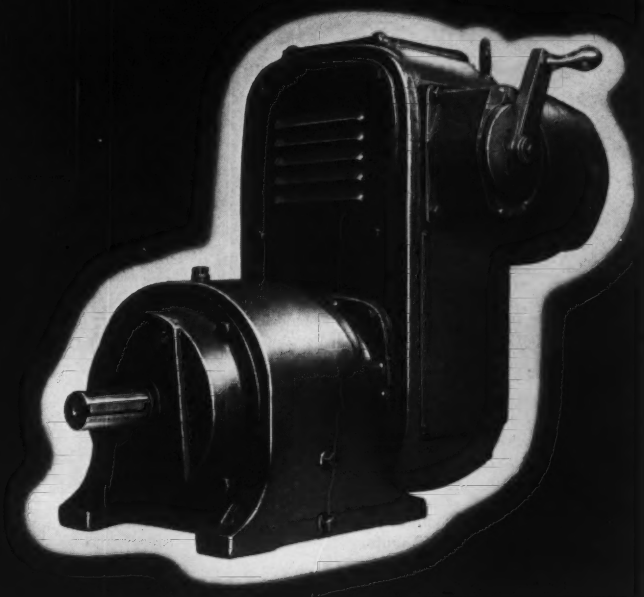
RACINE SECO

RACINE HYDRAULICS & MACHINERY, INC.

RACINE, WISCONSIN

One Source — One Responsibility for all your hydraulic circuit needs

Circle 440 on Page 19



You get all these PLUS VALUES with General Electric Mechanical Power Transmission Equipment

PRODUCT APPLICATION SERVICE—G-E engineers are available to help you analyze and select the right equipment for your job.

PROMPT SHIPMENT—You get fast delivery on all standard General Electric units—from distributor or factory stocks.

SALES SERVICE—Your inquiries, quotations and requests for bids are handled promptly by G-E field service offices.

AFTER SALES SERVICE—50 G-E Service Shops and 500 authorized Small Motor Service Stations offer expert repair service on all G-E Gear Motor products.

MANUFACTURER RESPONSIBILITY—G.E. focuses manufacturing responsibility at one source, for it produces *all* gearing, components and motors in its line.

MANUFACTURER REPUTATION—Advanced technology built into G-E mechanical power transmission equipment assures you that it will meet your specifications—adds to and builds preference for your product.

NEW General Electric Polydyne* drive provides DEPENDABLE LOW-COST ADJUSTABLE SPEED

straight from a-c power in ratings from 1/4 to 25-hp!

General Electric's new Polydyne drive is a compact, completely packaged unit consisting of a-c driving motor, belt transmission, output gearing and control.

NOW IN STOCK—These factory- and field-tested drives are available in configurations and ratings to meet virtually all your requirements!

G-E Polydyne drive has a completely new control design that prevents binding or sticking of speed control mechanism, and it responds smoothly and quickly to speed adjustment. Polydyne mechanical adjustable-speed drive is the drive to use when and where you want:

- Most efficient process speed
- Maximum machine life
- Minimum maintenance requirements
- Machine versatility

EASY MAINTENANCE—Advanced design makes belt changing fast; reduces chance of damage to drive shaft and bearings during belt change and eliminates shaft realignment after change.

General Electric helical reducer gears can be removed as a unit for fast inspection, and Polydyne drives require minimum lubrication.

FOR MORE INFORMATION on G.E.'s complete PLUS LINE with Polydyne drive, contact your nearby G-E Apparatus Sales Office or Distributor, or write for bulletins: Polydyne Drive (GEA-6806), G-E Helical Gear Motor Line (GEA-6704), Shaft-mounted Speed Reducers (GEA-6616), Fractional Horsepower Gear Motors (GEA-6133A), Section 854-2, General Electric Co., Schenectady, N. Y.

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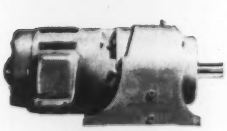
Progress Is Our Most Important Product

GENERAL ELECTRIC

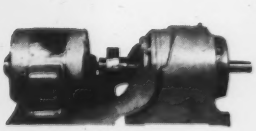
Circle 441 on Page 19

Choose from General Electric's PLUS LINE of Mechanical Power Transmission Equipment



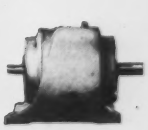
Integral-type gear motor

Right-angle shaft gear motor

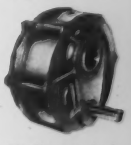


All-motor gear motor

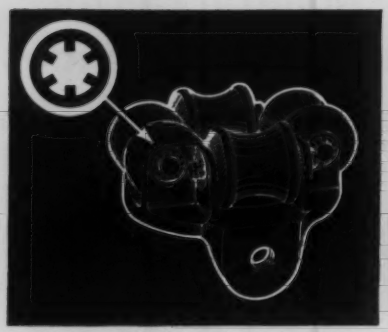
Offset-shaft gear motor



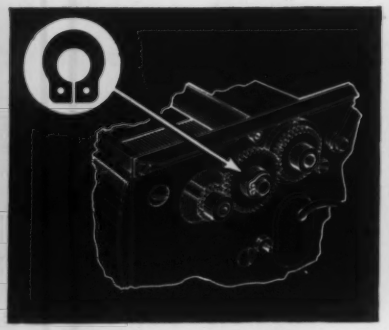
Helical speed reducer



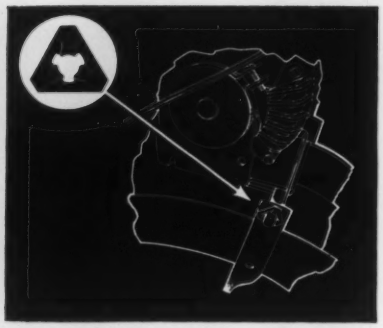
Shaft-mounted speed reducer



Drilling and flaring eliminated. Easier maintenance, a time saving of 50% and elimination of costly, time consuming drilling and flaring operations result when Truarc Series 5115 self-locking rings are used to retain rollers on pins in this electric cable guide. Extra long prongs enable ring to accommodate wide shaft tolerances.

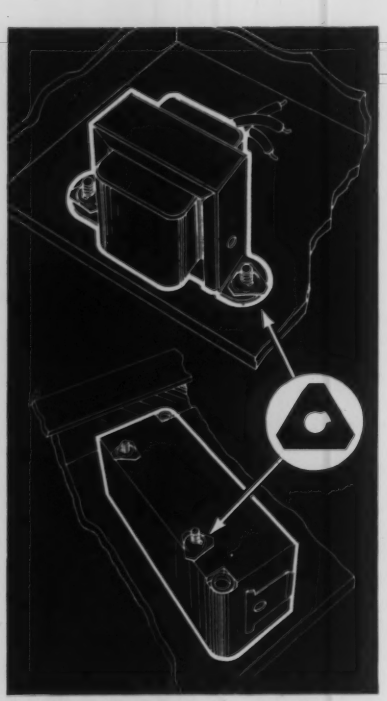


Economical fastening for idler gear. Installing Truarc Series 5555 Grip Ring flush with hub insures precise seating of gear in this portable electrocardiograph assembly. What's more, the ring eliminates a nut and costly stud-threading operation of alternate design. **Typical savings amount to $365 per 1000 units.**



Cross-drilling and cotter pin eliminated. Here a Truarc Series 5305 self-locking triangular retainer replaces a cotter pin used to hold an electric-motor mounting bar. Both the cotter pin and the cross-drilling operation required in the original design are eliminated. **Typical total savings amount to $120 per 1000 units.**

Truarc self-locking retaining rings boost economy in wide variety of designs



Easy way to mount electrical-electronic parts. Truarc Series 5300 triangular nuts replace conventional nuts and lockwashers in mounting electrical parts like transformer (top) or Microswitch (bottom). Dished body of Series 5300 flattens under torque, eliminates need for lockwasher, simplifies handling and assures assembly.

...eliminate parts, machining, speed assembly

Easy application, elimination of more expensive conventional fasteners and reduction or elimination of machining operations are just a few of the savings resulting from the proper use of self-locking retaining rings. Rings replace threaded retainers and nuts, hairpin-type cotter pins, and a variety of cut, lock, and plain washers. They require no groove, or preparatory machining operations. Rings can be installed by unskilled labor, seated at any point on the shaft, automatically taking up any accumulated tolerances.

Four ring types are shown. One has a dished triangular body which locks the fastener on the shaft under spring tension, holds under moderate shaft tolerances and against extremely heavy thrust loads. Another, a re-usable Grip Ring, is ideal for ungrooved shafts, tubes, bosses, and studs. A third type is a triangular free-spinning nut with a dished body that flattens under torque, eliminating need for separate lock washers. The fourth, a push-on type, has an arched rim to provide high strength and extra long locking prongs which accommodate wide shaft tolerances.

These are but four of the 50 functionally different types of Truarc retaining rings. They come in 740 standard sizes, 6 metal specifications, 13 different finishes. The entire Truarc line, including assembly tools, grooving tools, and 80 typical cost-saving applications, is covered in the new catalog RR 10-58. And remember, Waldes engineers are always ready to help you solve your application problems—whether they involve one of the standard Truarc rings or a "special" to fit your particular requirements. Waldes Kohinoor, Inc., 47-16 Austel Place, Long Island City 1, N.Y. 9.15

WALDES
TRUARC®
RETAINING RINGS
Waldes Kohinoor, Inc., Long Island City 1, N. Y.

TRUARC RETAINING RINGS . . . THE ENGINEERED FASTENING METHOD FOR REDUCING MATERIAL, MACHINING AND ASSEMBLY COSTS

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FOR MISSILES . . . OR FOR YOUR POWER CYLINDER APPLICATIONS . . . ANKER-HOLTH RELIABILITY MEANS OPTIMUM PERFORMANCE

Reliability of all missile components is of critical importance. This is one reason why Anker-Holth has furnished the power cylinders in BOMARC installations throughout the country to activate the launcher shelters, sliding them away in seconds prior to firing. Reliability in the products you make is important, too; in the superior performance, lowered operating costs and increased market acceptance. Specify Anker-Holth power cylinders for all of your pneumatic and hydraulic applications. Send for illustrated catalog today.

ANKER HOLTH

DIVISION, THE McDOWELL-WELLMAN COMPANIES

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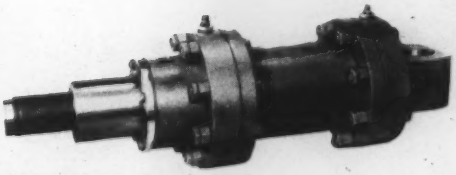
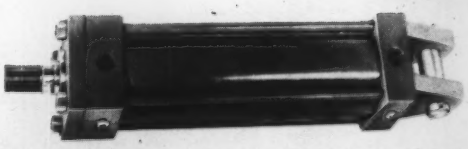
Heavy duty mill type cylinder





Square head type hydraulic cylinder

JIC Standard and Special Cylinders For Every Application

A2

ANKER-HOLTH DIVISION
THE WELLMAN ENGINEERING CO.
2723 Connor St., Port Huron, Michigan, USA

☐ Please send me your complete catalog.

☐ Please send me information for the following application _____

_____

Name _____

Title _____

Company _____

Address _____

What will they think of next!

. . . what new modifications of the Fenwal 541 Temperature Controller will equipment designers ask for?

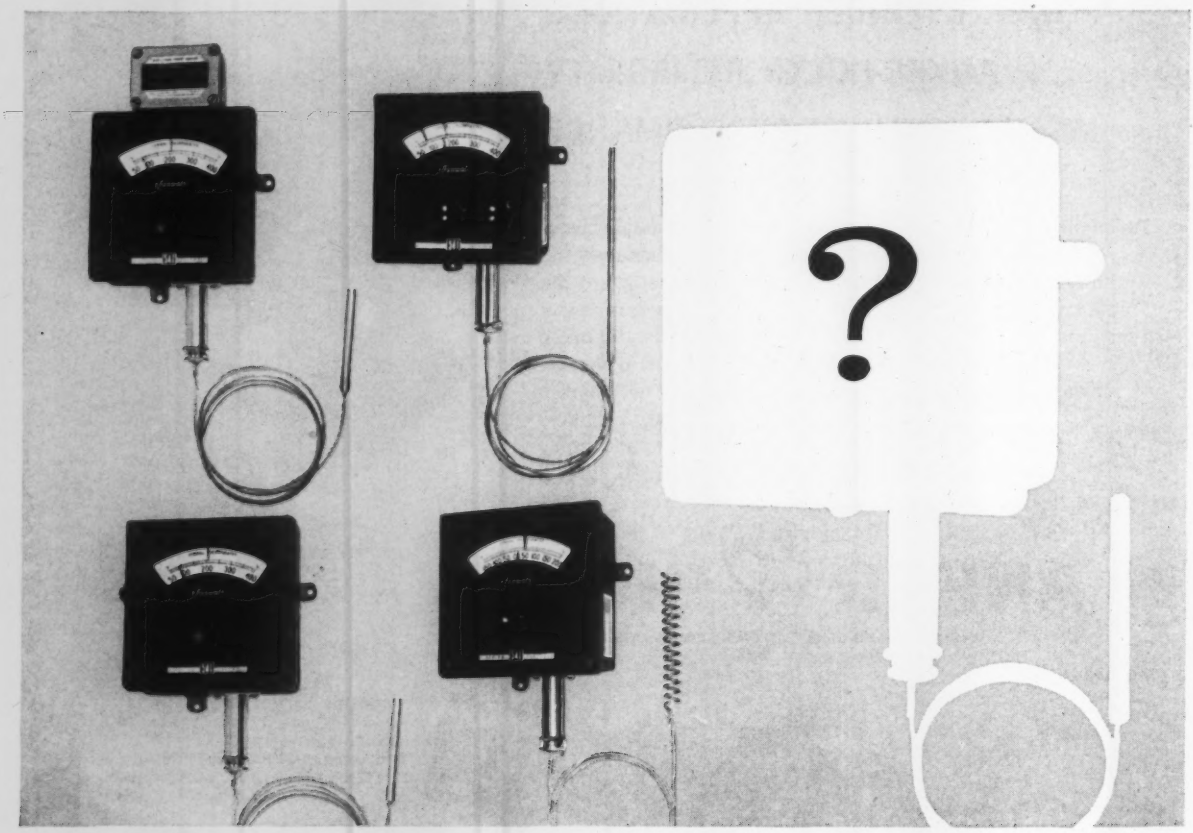
Luckily our engineers designed this liquid-filled bulb and capillary tube indicator controller for easy adaptation. It's been specified for applications ranging from gas burner control to fuel temperature control in missile ground support equipment. *Yet, basically, it's always the same, simple "black box"!*

The secret is case space. Room for up to 3 snap switches providing 3-point control. Nine-pin connector available for quick connect/disconnect to power source. Choice of 5 standard temperature ranges between −150° to +700°F (or special ranges). *Can control as many as four circuits simultaneously!*

Also . . . welded steel, splash and dust resistant case in black or gray crinkle finish, white enamel, or special color. Available completely fungus resistant. Mounts flush or on panel. Pilot light, if desired and . . . *every detail for each specific application!*

Design this competitively priced, high-efficiency controller into *your* product. Details from Fenwal Incorporated, 1910 Pleasant Street, Ashland, Massachusetts.

All moving parts of the rugged Fenwal 541 Temperature Controller operate in opposition . . . compensate for wear and maintain perpetual high accuracy. Ratings: 15 and 20A-125-250VAC; .50A-125VDC; .25A-250VDC.



ANOTHER EXAMPLE OF HOW **Fenwal** CONTROLS TEMPERATURE . . . PRECISELY

Circle 444 on Page 19

new, revolutionary, unique—won't freeze, won't stick—Here, for the first time, is a variable speed sheave that won't freeze, won't stick. It's Wood's new "MS" motion control sheave and it completely eliminates problems resulting from fretting corrosion. No more downtime, running through the speed range or dismantling. And, under normal operating conditions, the oil reservoir requires checking only twice a year. These startling advantages are made possible by two exclusive and revolutionary features . . . Wood's resilient rubber keys and continuous, rotational oil pumping action. Don't miss these and many other advantages.

send for bulletin 4101

Woods

T. B. WOOD'S SONS COMPANY
CHAMBERSBURG, PENNSYLVANIA
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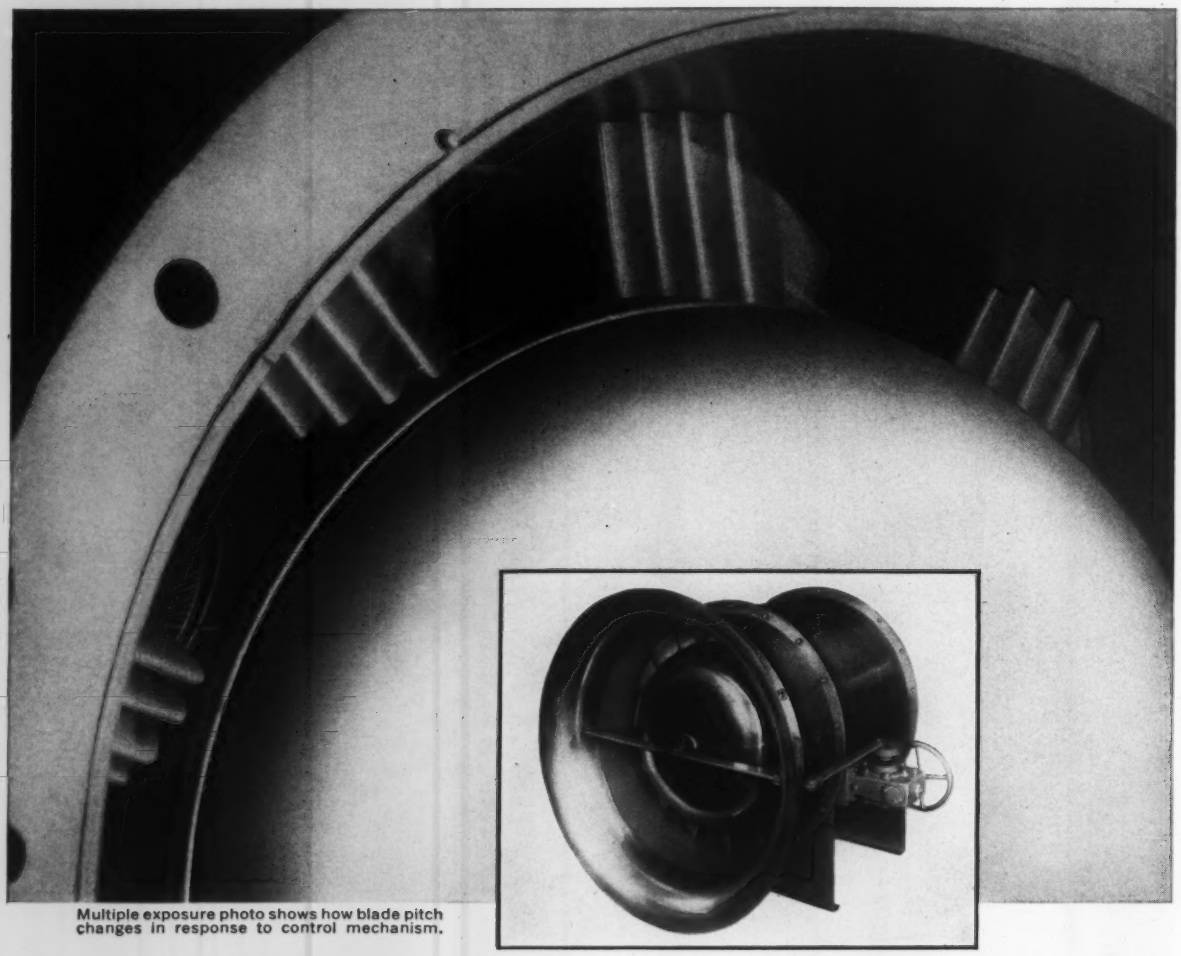
Circle 445 on Page 19



Multiple exposure photo shows how blade pitch changes in response to control mechanism.

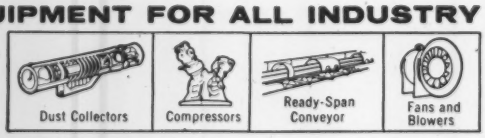
Automatic Adjustment of Air Supply to CO_2 Concentration, Temperature or Humidity with Joy Controllable Pitch Axivane® Fans

The blade pitch on Joy Axivane Fans can be changed automatically while the fan is running, varying the air volume as much as ±20%. The controlling mechanism can be linked to a sensing device to make air volume respond to a change in ambient temperature, humidity, concentration of a gas, or any of a number of conditions.

Controllable Pitch Joy Axivane Fans are ideal for ventilation of vehicular tunnels and work areas in which noxious gases tend to collect, maintaining air cooled equipment at an even temperature, stabilizing moisture content in an area, or any application requiring a variable supply of ventilation air.

Write for complete details on how Joy Controllable Pitch Axivane Fans can be made to suit your particular situation. Ask for bulletin 289-64-B.

AIR MOVING EQUIPMENT FOR ALL INDUSTRY



JOY

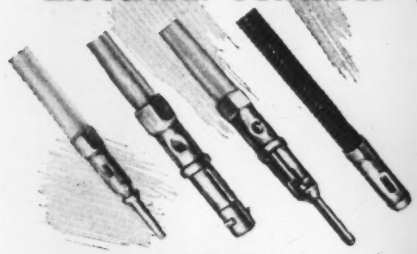
Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

WSW I 7482-289

Circle 446 on Page 19

BURNDY
Electrical Contacts



and BURNDY
Installation Tooling

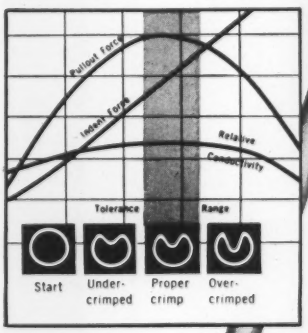
Designed for each other

HYPRESS® YD
A semi-automatic pneumatic tool for installing contacts. Contacts are supplied in expendable plastic carry strips. The tool can be operated as a portable tool, or hand or foot operated as a bench-mounted tool. Full cycling control insures uniform completion of each installation.

HYTOOL® M8ND
A manual tool with removable dies. Ratchet action insures that dies close completely and thus eliminates the possibility of incomplete connection.

HYPRESS Y8ND
A pneumatic portable tool for rapid installation of contacts. Removable dies are interchangeable with M8ND. Full cycling control insures uniform completion of each installation.

TOOLS / CONNECTORS MATCHED BY WORK CURVE STUDIES



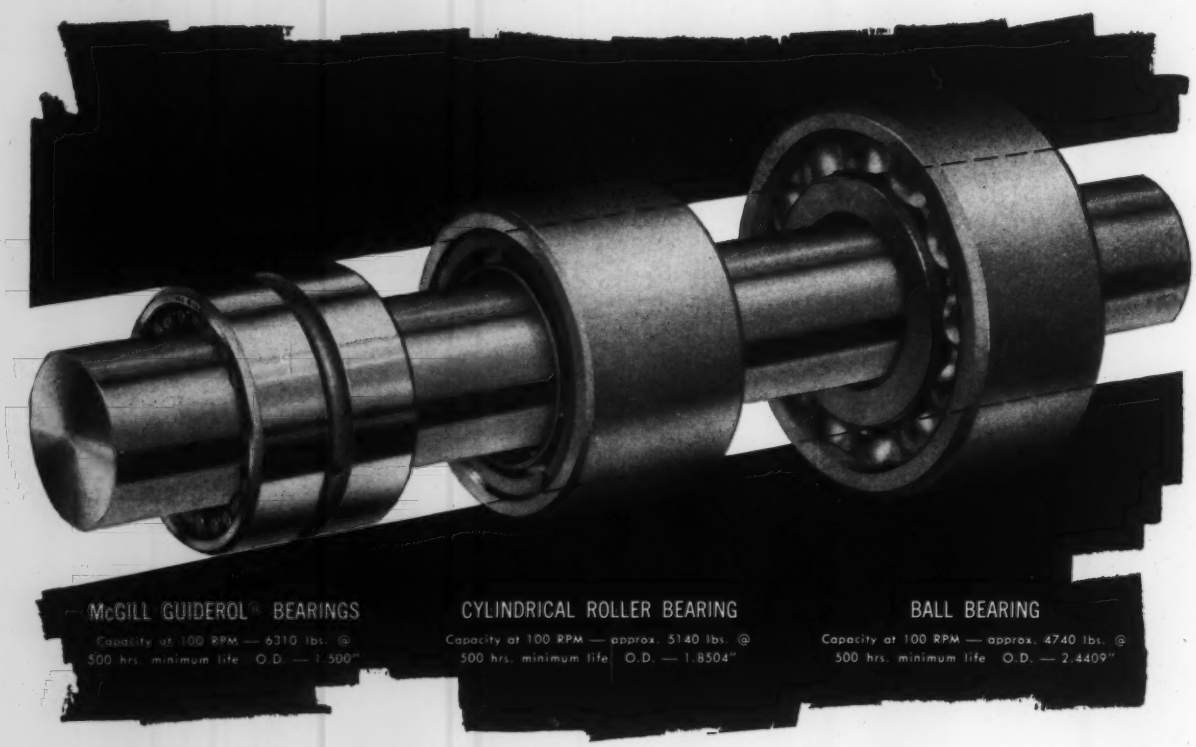
Laboratory work curves like this establish the proper type and depth of indent for every type of connector and wire. This depth then becomes an inherent characteristic of a full cycling control tool, guaranteeing a uniform and complete crimp each time a contact is installed. Thus the tool contributes to the built-in reliability of contacts and tooling **designed for each other.**

For details on these and other Burndy tools, write
OMATON DIVISION

BURNDY

59-17

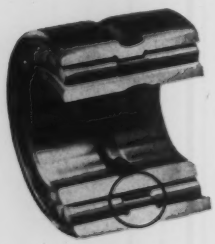
Norwalk, Connect. | In Europe: Antwerp, Belgium | Toronto, Canada


McGILL GUIDEROL® BEARINGS
Capacity at 100 RPM — 6310 lbs. @ 500 hrs. minimum life O.D. — 1.500"
CYLINDRICAL ROLLER BEARING
Capacity at 100 RPM — approx. 5140 lbs. @ 500 hrs. minimum life O.D. — 1.8504"
BALL BEARING
Capacity at 100 RPM — approx. 4740 lbs. @ 500 hrs. minimum life O.D. — 2.4409"

GUIDEROL® BEARINGS SAVE RADIAL SPACE .....and still offer greater load capacity

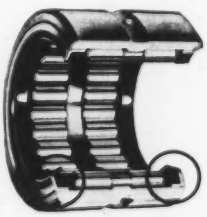
This graphic illustration demonstrates the radial space saving advantages of McGill GUIDEROL bearings that offer still greater capacity than the other two types of bearing compared. For a common 1" shaft, the GUIDEROL bearing GR-16 has an O.D. of only 1½" with a capacity of 6310 lbs. Compared to a cylindrical type roller bearing the GUIDEROL bearing requires ⅜" less housing space and offers 23% more capacity. A ball bearing for the same shaft uses almost an inch larger O.D. to carry 1500 lbs. less radial load.

CENTER GUIDED ROLLERS



GUIDEROL bearings pack more performance into smaller radial space. Their construction offers the inherent high capacity of a full complement needle bearing combined with effective roller control. Center guided rollers limit roller skewing tendencies and prevent binding under adverse conditions in either horizontal or vertical mountings. This qualifies GUIDEROL bearings for applications which are too heavily loaded for retainer type needle bearings, but are subject to misalignment that precludes the use of unguided needle bearings. Standard GR series GUIDEROL bearings are available, with or without inners, in shaft sizes from ⅝" to 9¼" with capacities ranging from 2880 lbs. to 128,670 lbs. (at 100 RPM).

LUBRICATION LOCKED IN, CONTAMINATION OUT; IN SEALED GUIDEROL BEARINGS



Pre-lubricated and sealed SG series GUIDEROL bearings are interchangeable dimensionally with standard GR series GUIDEROL bearings. They offer 5 possible seal combinations. Specify the sealed bearings for applications that are exposed to dust, dirt, grit or where accessibility for lubrication is a problem. Your McGill representative will be happy to assist you with special application problems. Ask him for recommendations or write the McGill Engineering Department.

For Complete Data on Dimensions, Capacities and Application of McGill Precision Needle Bearings, Send for Free Catalog No. 52A.

engineered electrical products

McGILL®

precision needle roller bearings

McGILL MANUFACTURING COMPANY, INC., BEARING DIV., 200 N. LAFAYETTE ST., VALPARAISO, INDIANA

Circle 448 on Page 19

Design for full production efficiency: Continuous-Cast Bronze Castings.

Lower material costs, faster production, better products. Certainly a powerful set of reasons for evaluating Asarco's unique process of casting shapes in continuous lengths. The alloys produced by continuous casting are in accord with SAE, ASTM, and government specifications but their performance is demonstrably superior to similar alloys cast other ways. So superior in hardness, tensile, yield, and impact strength, that you may be able to substitute an Asarcon® bronze for a high-cost aluminum or manganese bronze. You get the shape you need in the exact lengths you need, with minimum clean-up necessary, machinable on high speed machines. Immediately available in 260 *stock* sizes: Asarcon 773 (SAE 660) Bearing Bronze, rods and tubes, ½″ to 9″ in diameter, lengths up to 105 inches. Special shapes can be made to order. Write today for free booklet on Asarco continuous-casting to Continuous-Cast Products Department, American Smelting and Refining Company, Barber, N. J. West Coast Distributor: Kingwell Bros., Ltd., 457 Minna St., San Francisco. In Canada: Federated Metals Canada, Ltd., Toronto and Montreal.

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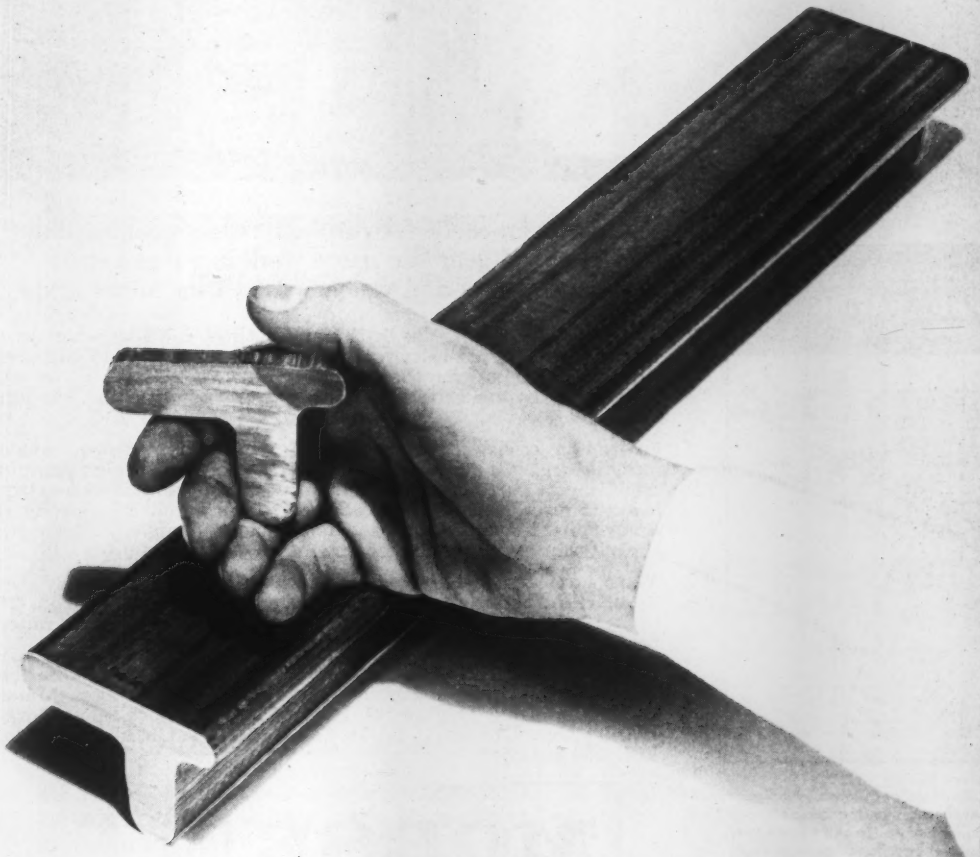
CONTINUOUS-CAST DEPARTMENT OF

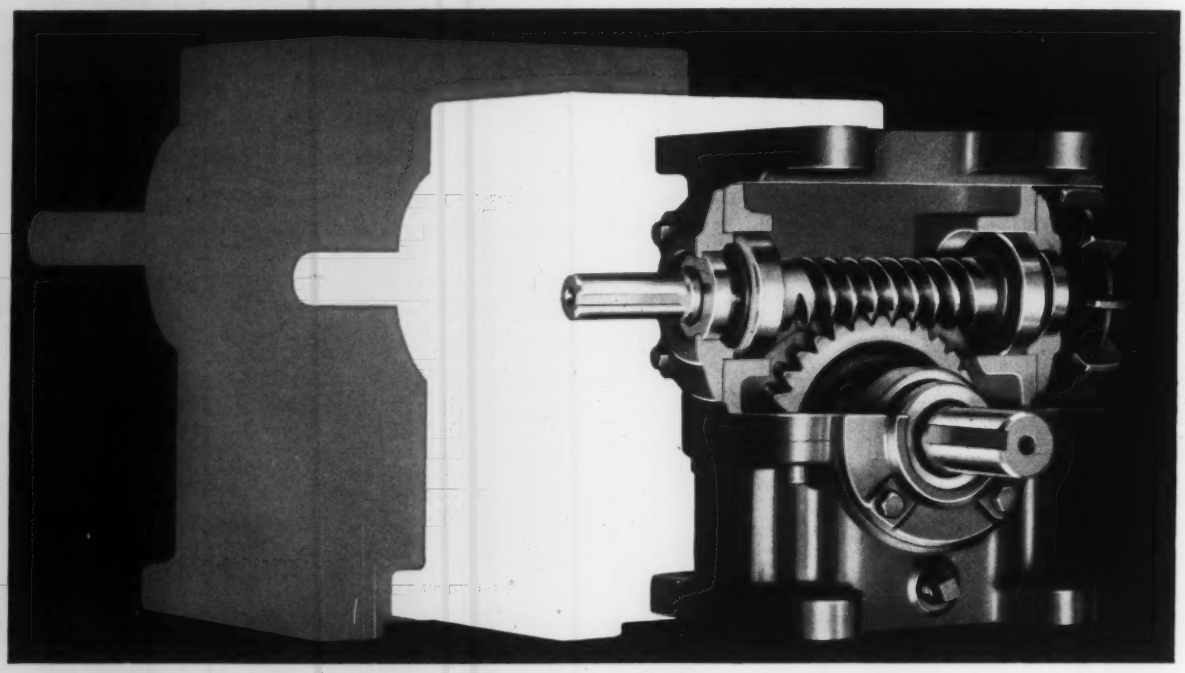


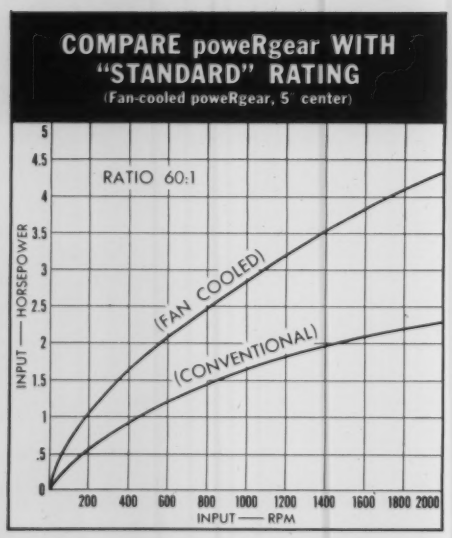
ASARCO

AMERICAN SMELTING AND REFINING COMPANY

Based on performance, Morse Eberhardt-Denver Speed Reducers give you:

MORE CAPACITY FOR YOUR MONEY





These curves compare a 5 inch center distance poweRgear with a 5 inch center conventional non-fan cooled heavy duty unit. Because of its fan-cooled design and extra-heavy construction, a Morse E-D poweRgear Speed Reducer easily exceeds "standard" ratings . . . delivers *more* horsepower per dollar!

Fan and fin cooling, extra-heavy-duty construction let poweRgear® do *more* work in a given size; you save space and weight, often trim initial costs

You get *more* than "rule-of-thumb" ratings call for, when you specify stock Morse Eberhardt-Denver poweRgear Speed Reducers. You pick and pay for the capacity you *need* . . . get it, as set realistically by exhaustive laboratory tests and critical on-the-job ratings.

Fan-and-fin cooling holds operating temperature down, sends rated life up on a poweRgear reducer. Its universal design permits mounting in bottom, top or vertical positions and includes extra-heavy housing, shafts and bearings. Result: you can specify a smaller, lighter, more compact unit to do your job . . . get *more* capacity for every reducer dollar.

There's a Morse E-D poweRgear reducer for *every* job: fractional to 40 H.P.; ratios from 5:1 to 3600:1; center distances from 2″ to 7″. Other Morse E-D speed reducers: conveyor drives; miter boxes; helical reducers; gear motors; worm and gear sets.

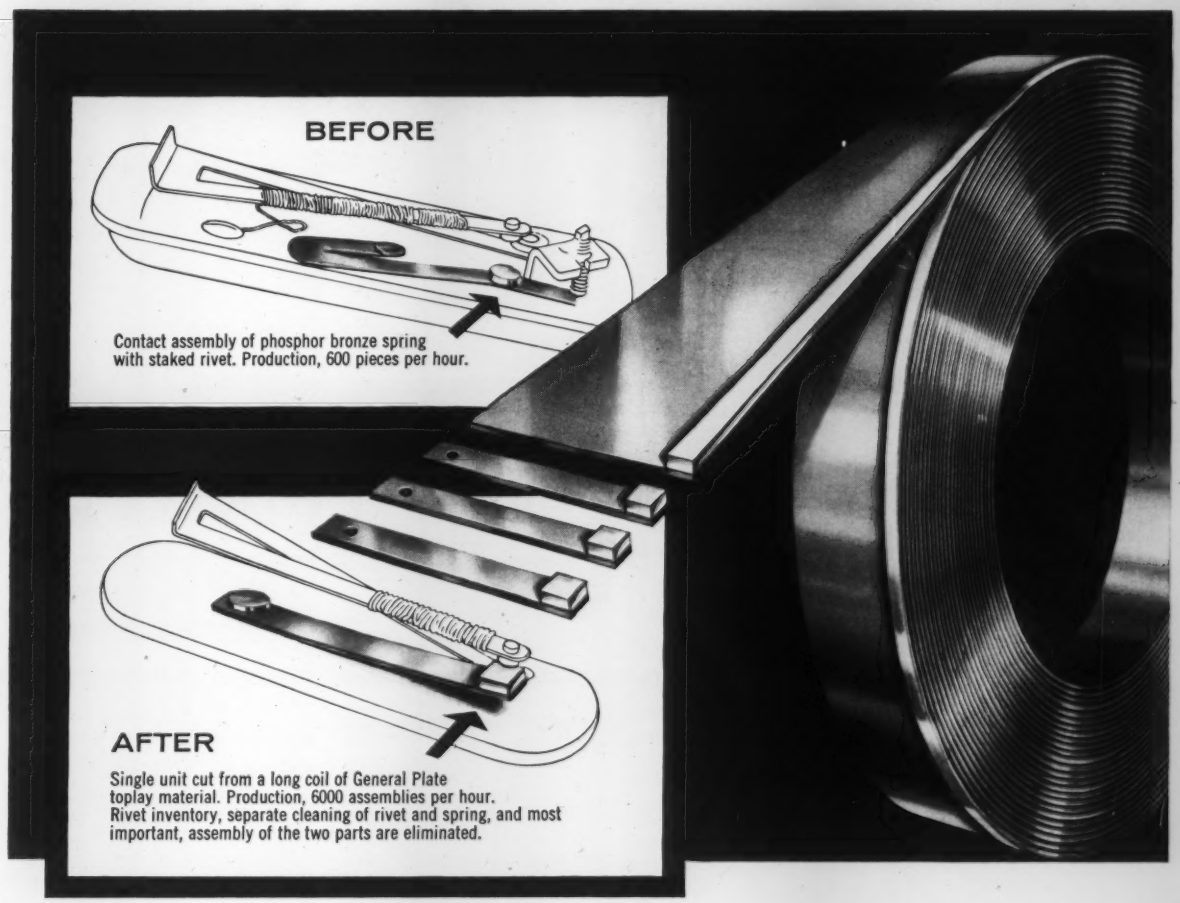
FOR MORE FACTS, call your Morse distributor today (see the Yellow Pages under "Power Transmission.") Or write: Morse Chain Company, Dept. 6-109, Ithaca, N. Y. Export Sales: Borg-Warner Intl., Chicago 3, Ill. In Canada: Morse Chain of Canada, Ltd., Simcoe, Ont.

MORSE MORSE B-W BORG-WARNER *

*Trademark

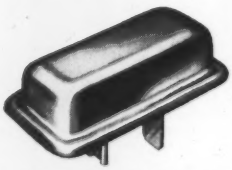
A BORG-WARNER INDUSTRY

ONLY MORSE OFFERS ALL 4: Chain and "Timing"® Belt Drives; Speed Reducers, Couplings, Clutches


BEFORE
Contact assembly of phosphor bronze spring with staked rivet. Production, 600 pieces per hour.
AFTER
Single unit cut from a long coil of General Plate toplay material. Production, 6000 assemblies per hour. Rivet inventory, separate cleaning of rivet and spring, and most important, assembly of the two parts are eliminated.

GENERAL PLATE TOPLAY MATERIAL ENABLES KING-SEELEY CORPORATION TO

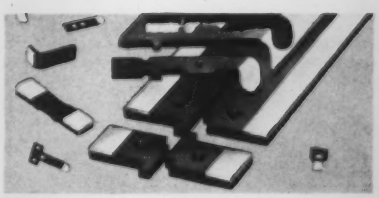
Increase Contact Assembly Production 900%



Recently King-Seeley Corporation, long a leading manufacturer of instrument panel gauges and other automotive equipment, redesigned the contact assembly in the constant voltage "CV" voltage regulator, a component of their constant voltage gauge systems. The old design called for blanking of a phosphor bronze spring, cleaning and finally staking of a General Plate rivet. By changing to General Plate toplay contact material the operation called for simply cutting off and cleaning. Expensive assembly operations were eliminated. The result . . . an increase in production of contact assemblies by 900%.

General Plate clad contact materials make it possible to manufacture complete contact assemblies to close tolerances by single blanking and forming operations. Compare this to other methods whereby the contacts and supporting members are fabricated separately and then assembled.

Let us make an electrical contact cost analysis on products you want to automate. Find out how General Plate clad electrical contact materials can be put to work for you. Write *now*.

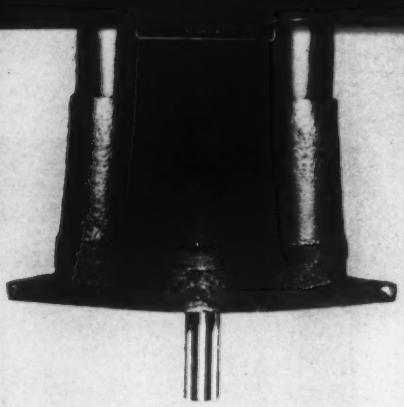


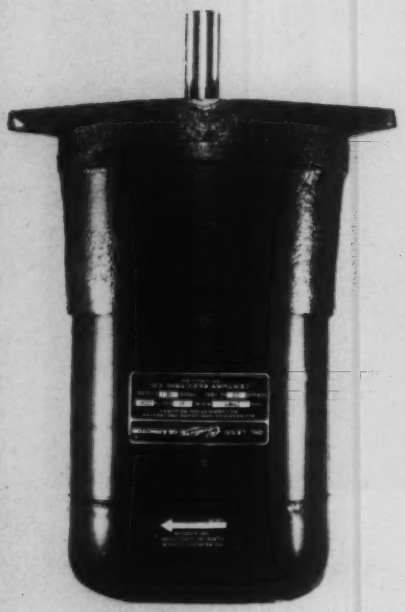
General Plate Clad Contact Materials . . . Single and double inlay, overlay and toplay provide better electrical performance, longer operating life and lower fabrication costs.

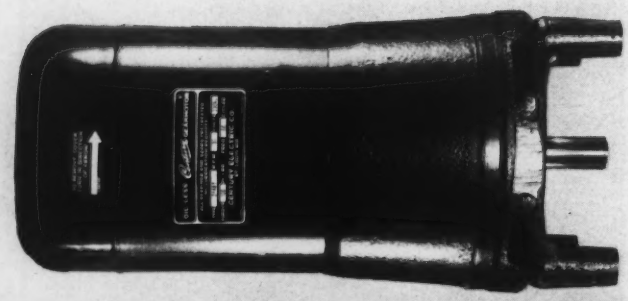
METALS & CONTROLS
809 FOREST STREET ATTLEBORO MASS., U.S.A.
A DIVISION OF TEXAS INSTRUMENTS INCORPORATED

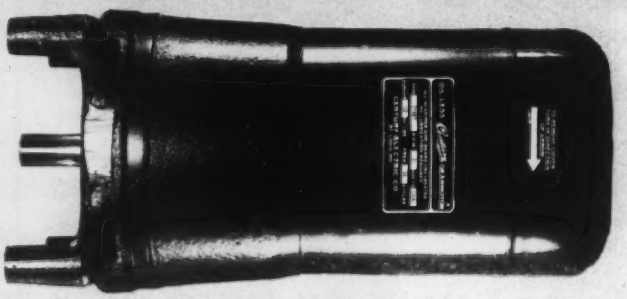
General Plate Products: Clad Metals • Electrical Contacts • Truflex® Thermostat Metal • Platinum Metals • Reactor Metals • Radio Tube & Transistor Metals

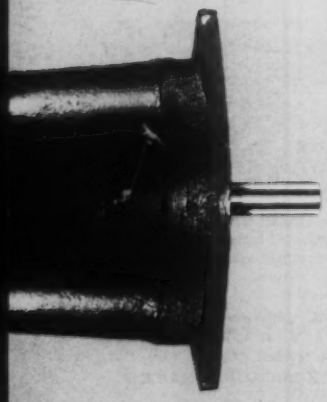
Circle 451 on Page 19

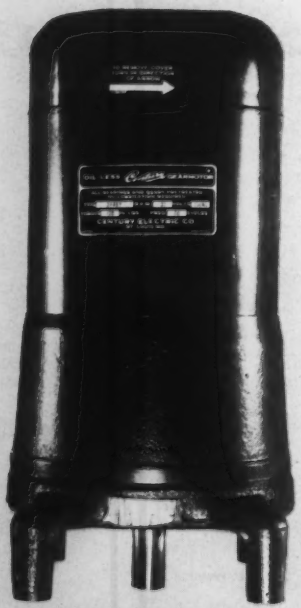


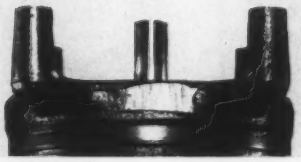






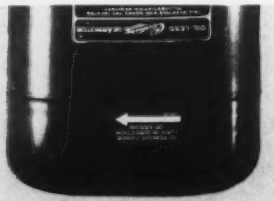






Any way it's mounted,

horizontally . . . vertically . . . at the sharpest angle, this new Century Electric gearmotor won't drip oil. Makes it ideal for applications where extreme sanitation is required. A variety of end plates are available besides the two basic types shown here.



Any way it's mounted

...this new Century Electric gearmotor can't drip oil

You can mount this new Century Electric gearmotor horizontally . . . vertically . . . at any angle and it still can't drip oil. Here's why:

Instead of oil, gears are pretreated with a fluid paste while being assembled. Paste becomes embedded in gears and won't wear, drip or fly off. No further lubrication is needed. Means you have no lubrication maintenance worries with this gearmotor.

Clean operation—This new double-reduction, parallel-shaft gearmotor was designed for applications requiring clean running motors. Smooth housing exterior, cemented-on name plate and pressed steel dome make motor easy to keep clean. A stainless steel shaft is available at a small extra cost. Rigid sanitation requirements can be met with this gearmotor.

Compact power—In an overall length of only 13 inches the new Century Electric gearmotor unit delivers speeds of 30, 37 or 56 RPM. It's available with ⅛ hp split phase, single-speed or multi-speed motors. The compact unit requires little more space than a standard motor. And it can be used to drive equipment such as small conveyors, pumps, mixers and agitators.

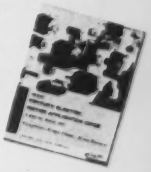
Reserve strength—Here are a few of the features which give the motor plenty of reserve strength for tough applications:

Helical gears and pinions are precision machined for quiet operation and long wear. Ball bearings support intermediate shaft.

Output shaft is supported by ball bearings carefully assembled to minimize end-play . . . stresses are carried by integral mounting flange or feet.

Gears run for years with minimum noise and vibration because all have rotational tooth contact. Intermediate low-speed gear is made of laminated phenolic material for even quieter operation.

Application aid—Century Electric sales engineers will be glad to discuss your gearmotor application problem with you. Century Electric makes all kinds of gearmotors—fractionals, integrals, polyphase, single phase and direct current—and Century makes a complete line of motors as big as 400 hp. You will find the new Century Electric Motor Application Guide helpful . . . please write for bulletin 270A. For *more* than a motor . . .

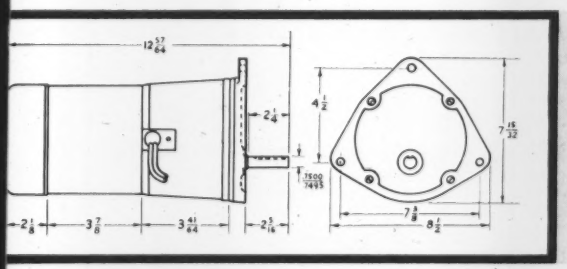


CENTURY ELECTRIC COMPANY

St. Louis 3, Missouri *Offices and Stock Points in Principal Cities*

Century

59-7



Mounting dimensions for new Century Electric, double-reduction, parallel-shaft gearmotor. Available in ⅛ hp. Output speeds 30, 37 and 56 RPM.

Other new Gearmotors include Century's line of single-reduction, right-angle shaft gearmotors . . . they are available with both single phase and polyphase motors. Century also makes a complete line of integral hp. gearmotors.

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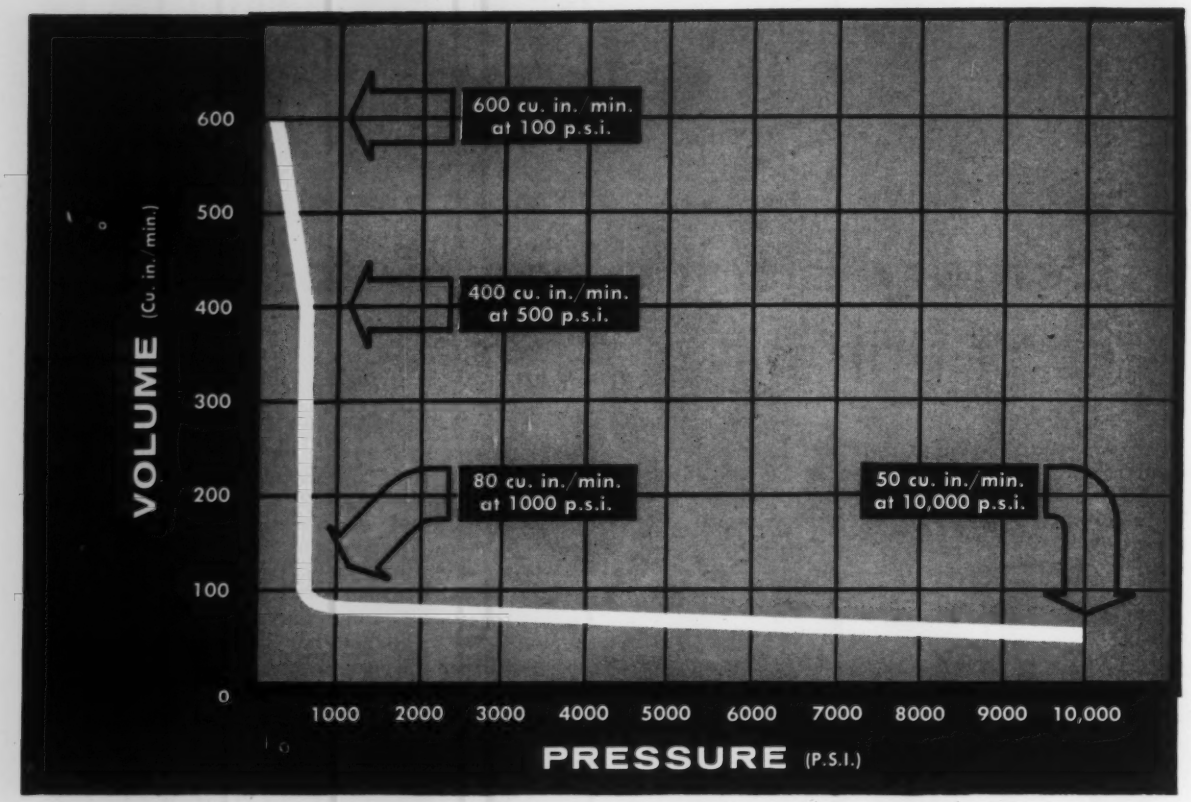


New Hydraulic Pump! Look Again at the Curve!

- **LIGHTWEIGHT, TWO-STAGE "POWER PACKAGE"**
- **WT. ONLY 45 LBS., 10¾" x 12⅝", 17½" HIGH**

The amazing, new OTC "Vanguard" hydraulic pumping unit is a quiet-operating, precision-built, two-stage hydraulic pump, driven by a universal motor, and consisting of a gear pump for the low pressure stage and a five-cylinder, axial-piston pump (which is supercharged by the gear pump) for the high pressure stage.

All wearing parts are made of finest tool steel, heat-treated and ground and lapped to assure efficiency and long life.

A variety of valves, controls and accessories are available and are easily mounted to meet your particular requirements.

Here is a power package that might well revolutionize much of tomorrow's designing in high pressure. Your interest, in reading this far, is well founded!

For bulletin and complete information, write:

RESEARCH · ENGINEERING · DEVELOPMENT

OTC

PRECISION HYDRAULICS DIVISION

OWATONNA TOOL COMPANY

712 N. Cedar Street, Owatonna, Minnesota

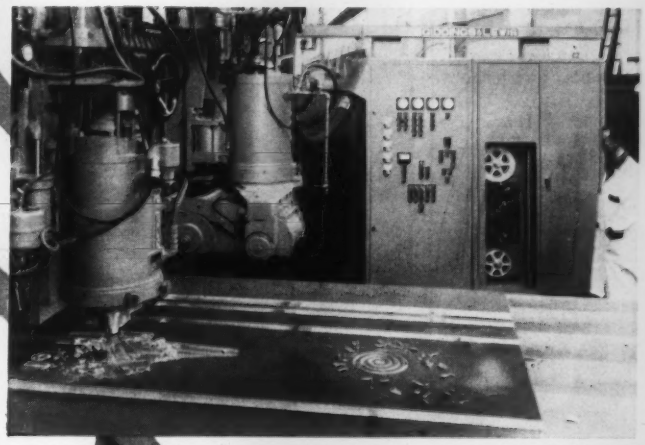
Circle 453 on Page 19

News about

B.F.Goodrich Chemical *raw materials*

Hycar helps insure accuracy of machine's

MAGNETIC MEMORY



Numericord System *made by Giddings & Lewis Machine Tool Company, Fond du Lac, Wisconsin, uses magnetic tape playback (seen through glass door in controller in photo) with tape manufactured by Reeves Soundcraft Corporation, Danbury, Connecticut. B.F.Goodrich Chemical Company supplies the Hycar polyacrylic rubber used in bonding metallic particles to tape.*

Profitable use of this machine tool automation system's "store of skills" depends on precision manufacture of tape to which magnetic particles are bonded with Hycar polyacrylic rubber. The tape stores and transmits design information which can be used to program a number of machines for mass production. Or stored tapes can replace a finished parts stock by providing fast, accurate reproduction of parts from blanks.

Magnetic particles have to be bonded uniformly over tape length to precise thickness. Hycar was selected for its stability, excellent adhesion and good binding qualities. Since tapes undergo frequent use and often have to be stored for long periods, the long wearing and good aging characteristics of Hycar are also important.

Here's another example of the way Hycar helps improve a product or makes possible new applications. Get more information by writing Dept. CM-5, B.F.Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

Hycar

Rubber and Latex

B.F.Goodrich Chemical Company
a division of The B.F.Goodrich Company

B.F.Goodrich GEON polyvinyl materials • HYCAR rubber and latex • GOOD-RITE chemicals and plasticizers

BISHOP Tubular Products NEWS

"METALS FOR PRECISION AND PERFORMANCE"

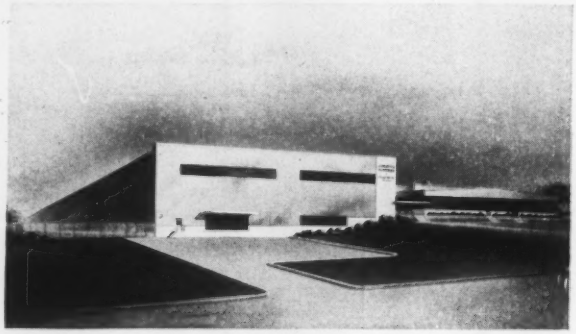
GOLD-CLAD STAINLESS TUBING CURBS CORROSION IN REACTOR

Photo pictures insertion of gold-clad stainless steel heat exchanger into gold-clad power reactor at AEC's Los Alamos Scientific Laboratory. Completely successful in recent operational tests, the unique reactor is designed to produce superheated steam in a single pass. This is the second experimental reactor using uranyl phosphate fuel—the first unit failed because of excessive corrosion in the heat exchanger. Gold-cladding now protects all structural parts in contact with the extremely corrosive solution.

Will clad metals solve *your* corrosion problems? Investigate the BISHOP line of clad metals. BISHOP was the first company to successfully produce gold-clad stainless tubing . . . coupon brings data. Use it.

Circle 455 on Page 19

NEW BISHOP TUBE MILL OPENS



Sketch shows new BISHOP facilities adjacent to the present tube mill in East Whiteland Township, west of Paoli, Penna.—completing the first stage in BISHOP'S long range expansion program. This two-story structure will contain over 165,000 square feet of floor space. BISHOP platinum mechanical manufacturing operations also move to the East Whiteland plant.

Circle 456 on Page 19

BISHOP NOW DRAWING .002" WALL TANTALUM TUBING

Tantalum tubing with paper-thin wall thicknesses is now being supplied by BISHOP on special order. Sizes range from .062 in. OD x .002 in. wall to 1.5 in. OD x .125 in. wall. Columbium (niobium) tubing down to .002 in. wall has been produced and is also available. Can tubing of these "exotic" metals be the answer to any of your design problems? Check with BISHOP . . . use the coupon.

Circle 457 on Page 19

J. BISHOP & CO.

platinum works

FOR HELPFUL DATA USE THIS HANDY COUPON

- ☐ Tubular Products Bulletin No. 12
- ☐ Platinum Products Catalog No. 4
- ☐ Clad Metal Data
- ☐ Special Tubing Data

Check information you'd like and mail to
J. BISHOP & CO.,
45 King St., Malvern, Penna.

Name _____

Position _____

Company _____

Address _____

City _____ Zone _____ State _____

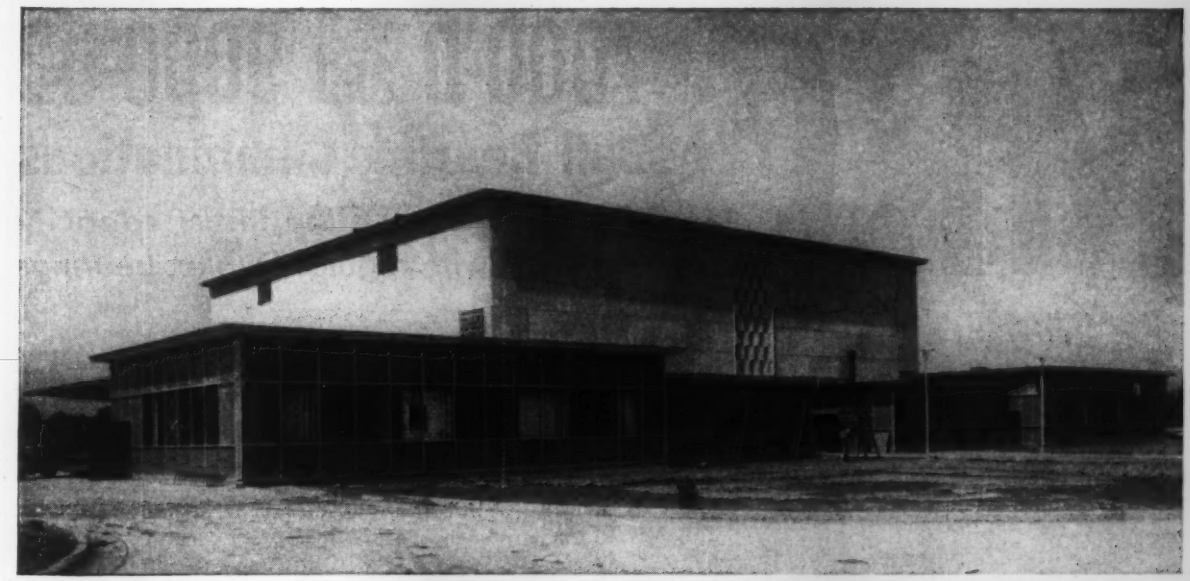
Tubular Products Division

45 KING STREET, MALVERN, PENNA.

NIagara 4-3100

THIS IS THE BISHOP LINE:

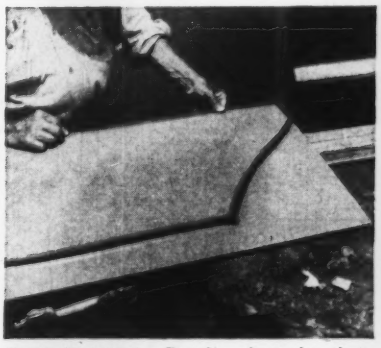
Products of all the Platinum Metals... Small diameter Stainless Steel, nickel and special alloy tubing



Architect: Voorhees, Walker, Smith, Smith & Haines
Contractor: Frank Briscoe

ENJAY BUTYL

solves weather problem and seals for sure!



Easily installed — Butyl preformed gaskets can be installed on-site or in the shop. They protect panel edges during handling.

Faster glazing — installation of lights is done quickly and more efficiently when edges are protected by Butyl preformed gaskets.

All-around weather protection — the superior resistance of Butyl to ozone, sunlight, heat and moisture provides a sure seal.

Modern mullion, sill and transom design requires highly efficient sections that insure a reliable sealing job. Low-cost Enjay Butyl rubber enables the design of trim, neat window details – provides a permanent weather-tight seal. In this application Butyl does a better job than conventional rubbers because Butyl gives superior resistance to ozone, sunlight, heat and moisture. This means Butyl resists cracking, crazing and loss of elastic properties.

Butyl preformed gaskets and spacers installed in this large research center located at Florham Park, N. J. were manufactured by Pawling Rubber Corp., Pawling, N. Y. For more information how Butyl rubber can help solve your design problems, contact your nearest Enjay office.

Enjay's extensive laboratories and expert staff are always glad to provide technical assistance.

EXCITING NEW PRODUCTS THROUGH PETRO-CHEMISTRY

ENJAY COMPANY, INC.

15 West 51st Street, New York 19, N.Y.

Akron • Boston • Charlotte • Chicago • Detroit • Los Angeles • New Orleans • Tulsa

ENJAY® BUTYL

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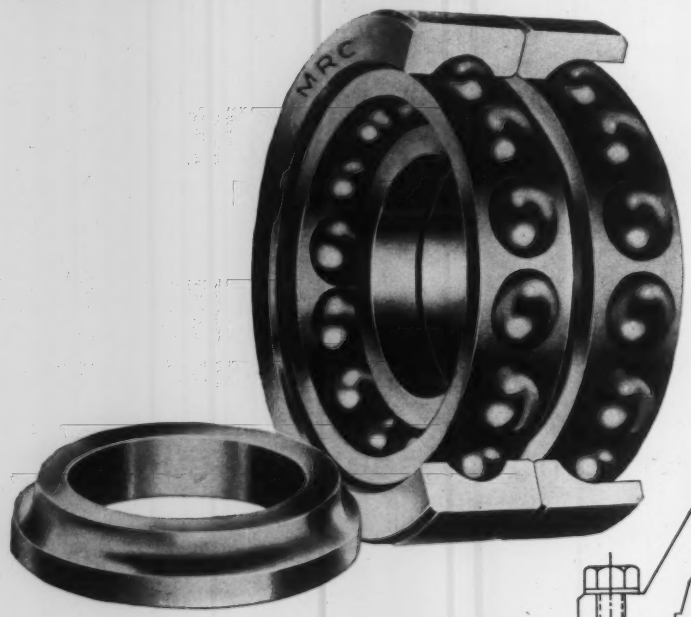
MRC 7000-D and 9000-UD

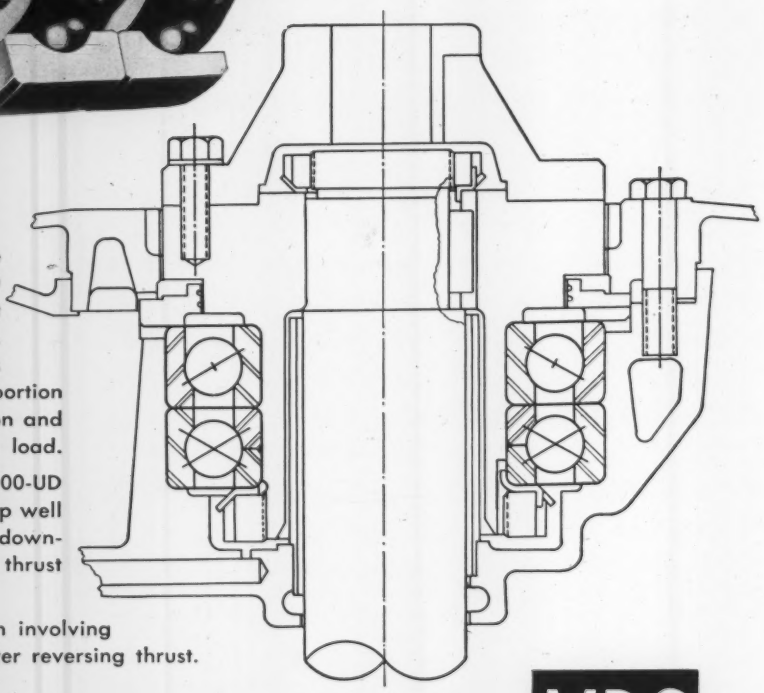
Ball Bearing Combinations

provide DOUBLE the thrust capacity available with regular Duplex bearings



M-R-C 7000-D single-row angular contact bearings and M-R-C 9000-UD single-row two-directional thrust bearings can be used in combination mountings to provide approximately double thrust capacity in one direction and single bearing thrust capacity in the opposite direction.

This combination mounting, requiring twice single-row width, results in almost 100% gain in thrust capacity in one direction, with no change in the other direction.



More than one 7000-D bearing may be used in conjunction with a 9000-UD bearing to provide still greater thrust capacity in one direction when required. The 9000-D single-row bearing performs the dual function of carrying its proportion of the heavy thrust load in one direction and supporting all of the reversing thrust load.

This combination of 7000-D and 9000-UD bearings was originally selected for deep well pump applications, supporting heavy downward thrust load as well as reversing thrust due to upsurge.

It is suitable for use in any application involving heavy thrust in one direction with lighter reversing thrust.

Consult OUR Engineering Department on YOUR bearing problems

MARLIN-ROCKWELL CORPORATION

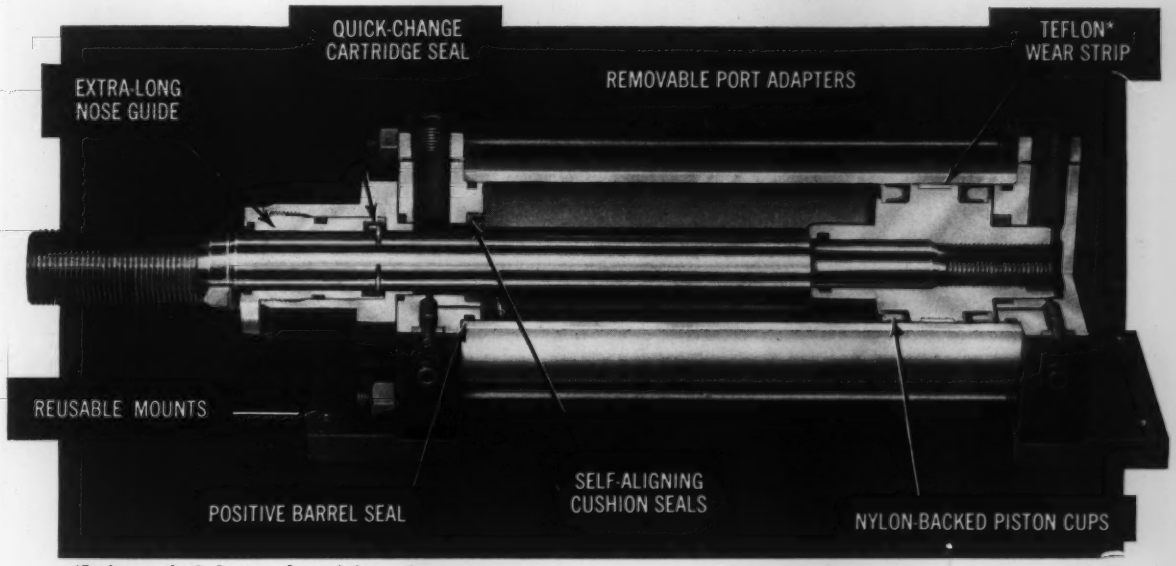
Executive Offices: **Jamestown, N.Y.**

MRC BALL AND ROLLER *bearings*

Circle 459 on Page 19

new... new... new... Valvair® HEAVY-DUTY AIR AND HYDRAULIC CYLINDERS

200 psi air, 300 psi hydraulic



*Trade name for Du Pont tetrafluoroethylene resin

...will provide efficient, dependable service on your high-production equipment

A look inside shows you why Valvair heavy-duty cylinders belong on *your* high-production machines! Built by Valvair, makers of famous SPEED KING valves, these heavy-duty cylinders provide design, construction and component material features coordinated to assure efficient operation, longest service life and minimum downtime.

Whether you're ordering new machines, or modernizing equipment now in use, it'll pay you to specify Valvair heavy-duty cylinders for all your high-production machines. A full range of bore and rod sizes, interchangeable *and reusable* mountings, stroke lengths and cushioning options are available.

Call in your nearby Valvair or Bellows field engineer today . . . take advantage of one-source responsibility for all your control system needs . . . cylinders, valves, manifolds, filters, regulators and lubricators.

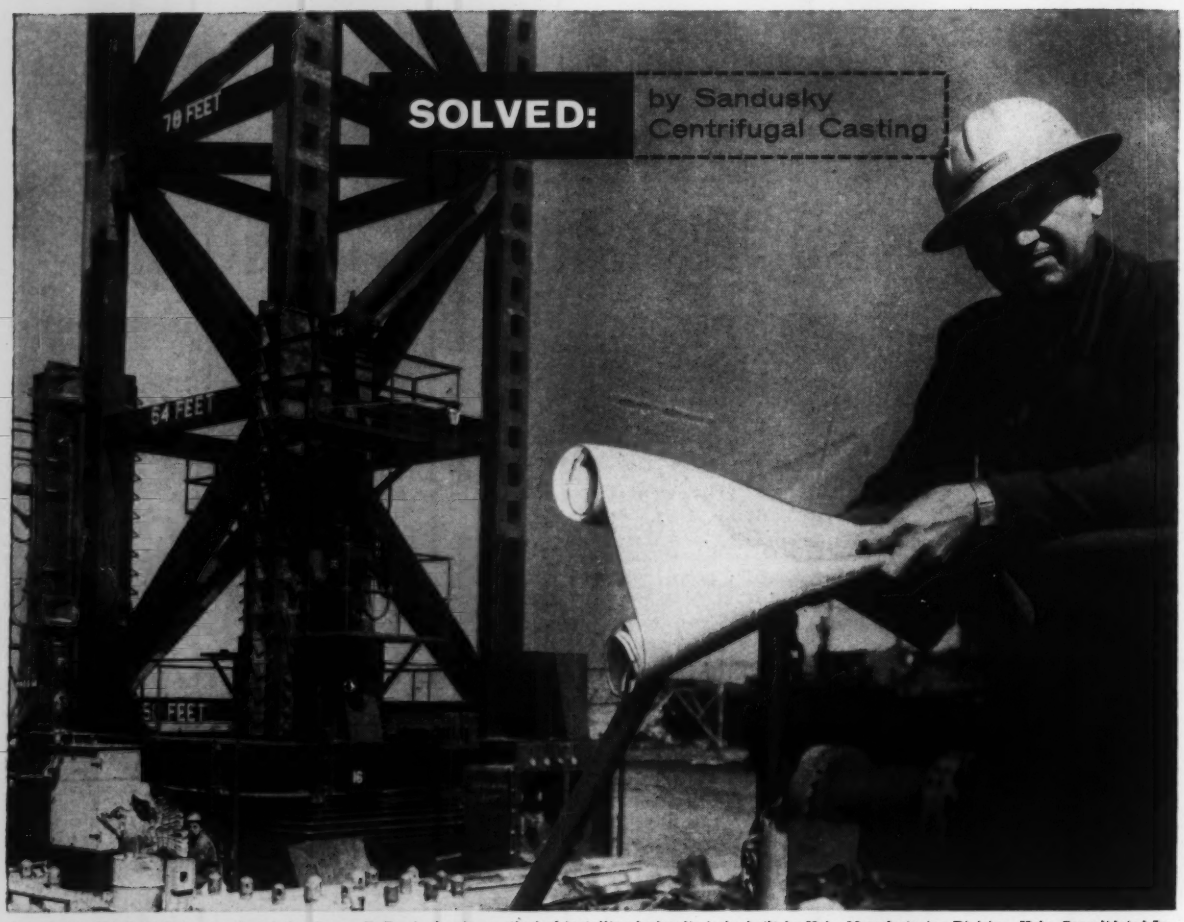
For detailed information, write for Bulletin VC-800. Address Dept. MD-1059, Valvair Corporation, Akron 11, Ohio

8038-1

Valvair AKRON 11, OHIO

Other INDUSTRIAL DIVISIONS of IBEC: The Sinclair-Collins Valve Co. The Bellows Co., Akron, Ohio • V. D. Anderson Co., Cleveland, Ohio.

VALVAIR AIR & HYDRAULIC CYLINDERS • SPEED KING CONTROL VALVES AND MANIFOLDS • PLUG-IN CONTROL VALVES AND MANIFOLDS
HI-SPEED INLINE VALVES • PILOT VALVES • MINI-KING VALVES • MANUAL VALVES • FILTERS • REGULATORS • LUBRICATORS



One of four 274 ft. high towers aboard the *George F. Ferris* showing method of installing hydraulic jacks built by Yuba Manufacturing Division, Yuba Consolidated Industries, Benicia, Calif. George Bauer, of Delong Corp., New York, is shown supervising construction while platform is being completed at Yuba's Richmond, Calif., plant.

YUBA gets quality-cost-delivery advantages by specifying 16 Sandusky cylinders

Sixteen 500-ton hydraulic jacks built by Yuba, for which Sandusky supplied the main cylindrical bodies, enable the new pipe-laying barge, *George F. Ferris*, to operate in waters 200 ft. deep!

This 5400-ton barge is equipped with four structural steel towers 274 ft. high. Four jacks on each of the towers provide the power to lower these steel "legs" to the ocean floor, raise the barge above the surface of the water, or retract the towers to render the barge navigable. The steel jack cylinders are Sandusky Centrifugal Castings, made to the requirements of ASME Code-approved SA-217, Section VIII, Unfired Pressure Vessels, to withstand operating pressures of 3000 psi. They were produced in 186″ lengths, machined to 24″ O.D. with 2″ thick walls and sectioned into four pieces 43″ long.

Yuba's selection of Sandusky Centrifugal Castings was based largely on three essential factors: QUALITY—meeting the exacting Code requirements . . . COST—saving about half the cost of an alternate method of manufacture . . . and DELIVERY—coming through on a tough time schedule by delivering all 16 cylinders within 21 working days!

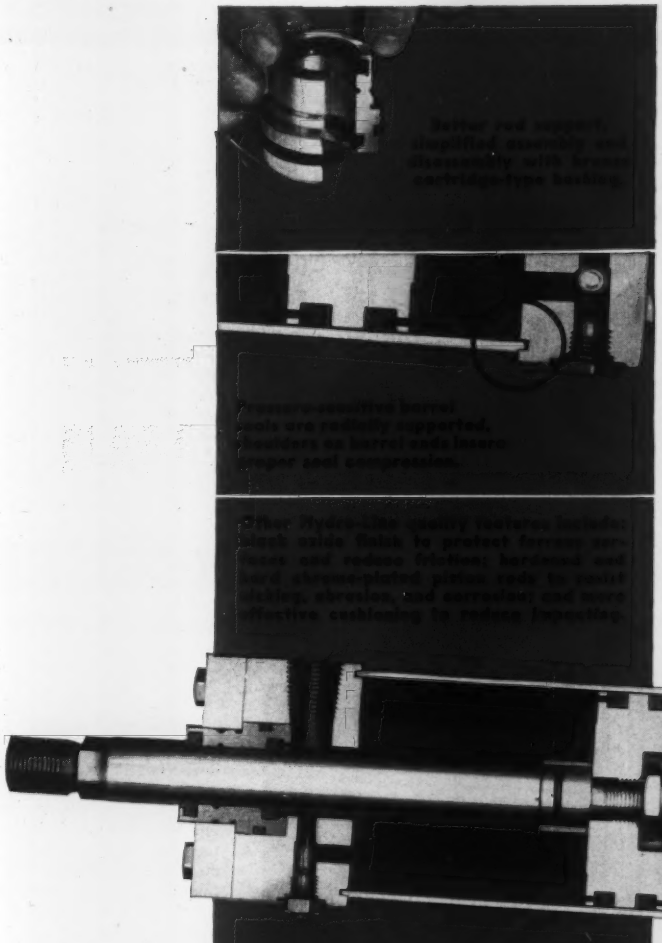
When you need cylinders from 7″ to 54″ in O.D. and up to 33 feet long it will pay you to get in touch with us. Write for our latest booklet, *Your Solution To Cylindrical Problems* containing data on more than 70 ferrous and non-ferrous alloys.

SANDUSKY CENTRIFUGAL CASTINGS
FOUNDRY & MACHINE CO.

5902

SANDUSKY, OHIO—Stainless, Carbon, Low-Alloy Steels—Full Range Copper-Base, Nickel-Base Alloys

Circle 461 on Page 19



"production-proved" design pays off 4-WAYS

There's only one place for a cylinder to prove itself — on the job — and Hydro-Line's "Production-Proved" design Series R2 cylinders are doing just that.
In air operation up to 200 psi or hydraulic applications in the 500-2500 psi range, they outperform the best of the rest!

Economical use of quality materials coupled with sound basic design give you these advantages:

1. Long, trouble-free life.
2. Peak operating efficiency.
3. Low maintenance costs.
4. Simplified installation.

You get all these qualities in a complete line of standard cylinders. Cylinders for more than 90% of applications are available for immediate shipment from factory stocks, permitting minimum cylinder inventories without jeopardizing production. Also, even on small orders Hydro-Line offers discounts on stock "R2" and "N" cylinders.

Only a few of the advantages of the new Hydro-Line Series R2 are shown. But — you can get more facts by filling in the coupon below or contacting the Hydro-Line sales engineer near you. Ask to see the Series R2 demonstrator for a close-up look at a truly efficient design.

HL HYDRO-LINE CYLINDERS

5602 PIKE ROAD • ROCKFORD, ILLINOIS

manufacturers of: high- and low-pressure hydraulic cylinders • heavy-duty air cylinders • adjustable-stroke cylinders • dispensing cylinders • intensifiers • single-acting cylinders • booster cylinders

act now!

Please send me additional data on the classes of Hydro-Line cylinders checked below, including complete information on deliveries from factory stocks:

( ) Series R2 (heavy-duty air, medium-duty hydraulic, industry standard)
( ) Series N (heavy-duty hydraulic, industry standard)
( ) Series S2 (automotive industry automation standards)

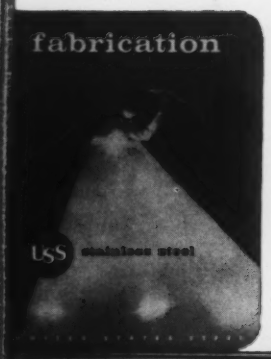
Name and Title_____
Company_____
City_____ State_____

HYDRO-LINE MANUFACTURING COMPANY
5602 PIKE ROAD ROCKFORD, ILLINOIS

Circle 462 on Page 19

"Design Manual for High-Strength Steels"

A 170-page handbook that discusses the essential principles of structural design, with formulas, charts, and tables for High-Strength Steels.

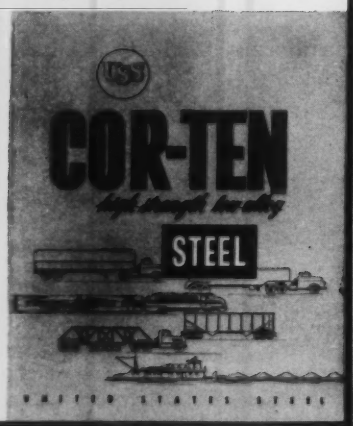


"USS Stainless Steel Fabrication Book"

Don't shy away from Stainless Steel because of supposed fabrication difficulties. It's easy to fabricate Stainless when the right methods are used, and this 130-page manual gives much information about correct fabrication practices.

"USS COR-TEN Steel"

58 pages devoted exclusively to the properties and applications of USS COR-TEN High-Strength Low-Alloy Steel. You'll be interested in the corrosion resistance of this remarkable steel.

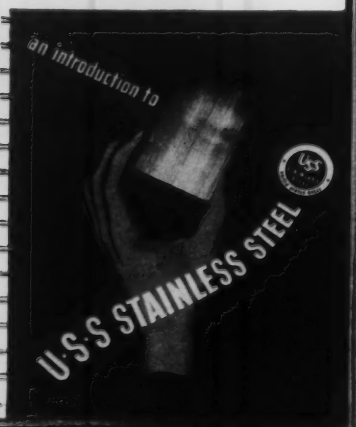


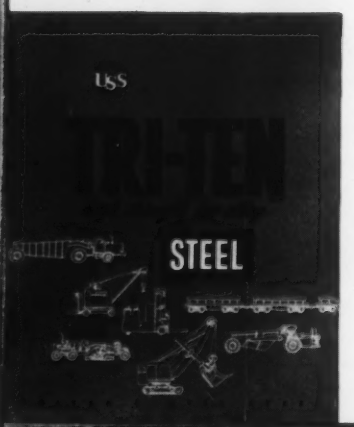
"USS 'T-1'"

A 64-page book about "T-1" Steel, the constructional alloy steel that combines toughness with exceptional strength—100,000 psi minimum yield strength. In addition to engineering data, metallurgical characteristics, and fabrication practices, you'll read outstanding case histories of "T-1" Steel in use.

"An Introduction to USS Stainless Steel"

This book is about the characteristics of USS Stainless Steels and their applications in many different industries.





"USS TRI-TEN Steel"

The prefix "TRI" was adopted for the name of the steel in this 32-page book because of its three predominant alloys—manganese, vanadium, and copper; and because of its three outstanding characteristics—strength, toughness, and weldability.

Are you one of the many design engineers who have read these free books?

100,000 people engaged in product design have already requested copies of these six free books from U.S. Steel. More than 60,000 copies were mailed in 1958 alone. If *you* design with steel, you'll probably find it worth-while to have your own personal copies. They contain almost everything you'll want to know about USS High-Strength Steels, USS Stainless Steels, and USS "T-1" Constructional Alloy Steel. You'll see how they reduce weight . . . increase strength . . . minimize corrosion . . . save thousands of dollars in steel costs. Send the coupon for any one or all of these free books.

USS, COR-TEN, TRI-TEN, and "T-1" are registered trademarks

USS United States Steel

Please direct inquiries to advertiser, mentioning MACHINE DESIGN

"Design Manual for High-Strength Steels" ☐

"USS Stainless Steel Fabrication Book" ☐

"USS COR-TEN Steel" ☐

"USS 'T-1'" ☐

"An Introduction to USS Stainless Steel" ☐

"USS TRI-TEN Steel" ☐

United States Steel
Room 6027, 525 William Penn Place
Pittsburgh 30, Pennsylvania

Please send free copies of the books I have checked:

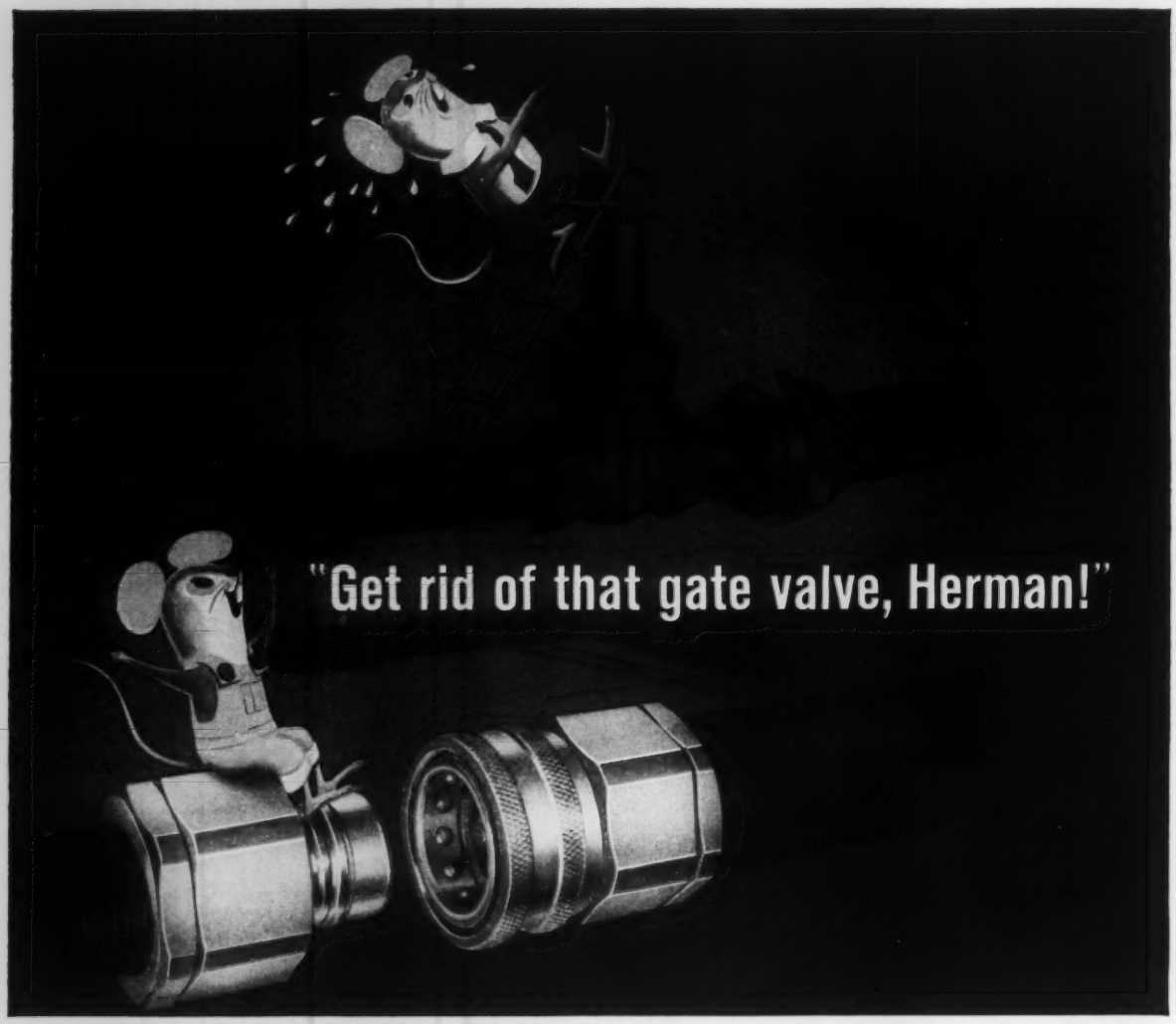
Name _____

Title _____

Company _____

Address _____

City _____ **Zone** **State** _____



Use Snap-Tite Valved Couplings and you'll always know when you've stopped the flow!

Use Snap-Tite valved couplings and you'll never have to test lines to see if flow has stopped as you do with conventional valves.

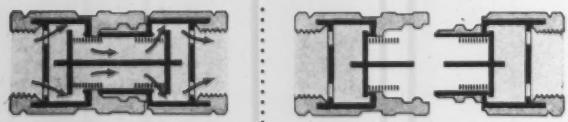
The instant you disconnect the two halves of a Snap-Tite coupling, flow stops . . . and you know at a glance the line is closed. Reconnect and right away full flow begins again.

Snap-Tite couplings take up less space, prevent the possibility of leaking valves, save time and money in installation and maintenance. Ask your local Snap-Tite representative how much you can save by using Snap-Tite couplings.

SIZES: 1/4" to 6" in aluminum, brass, steel and 303 and 316 stainless. Larger sizes and other metals on special order.

For more information, write for Snap-Tite Catalog #58. Ask for the name of your local Snap-Tite representative.

TO USE SNAP-TITE VALVED COUPLING:



CONNECT—Full flow instantly

DISCONNECT—Stop flow instantly

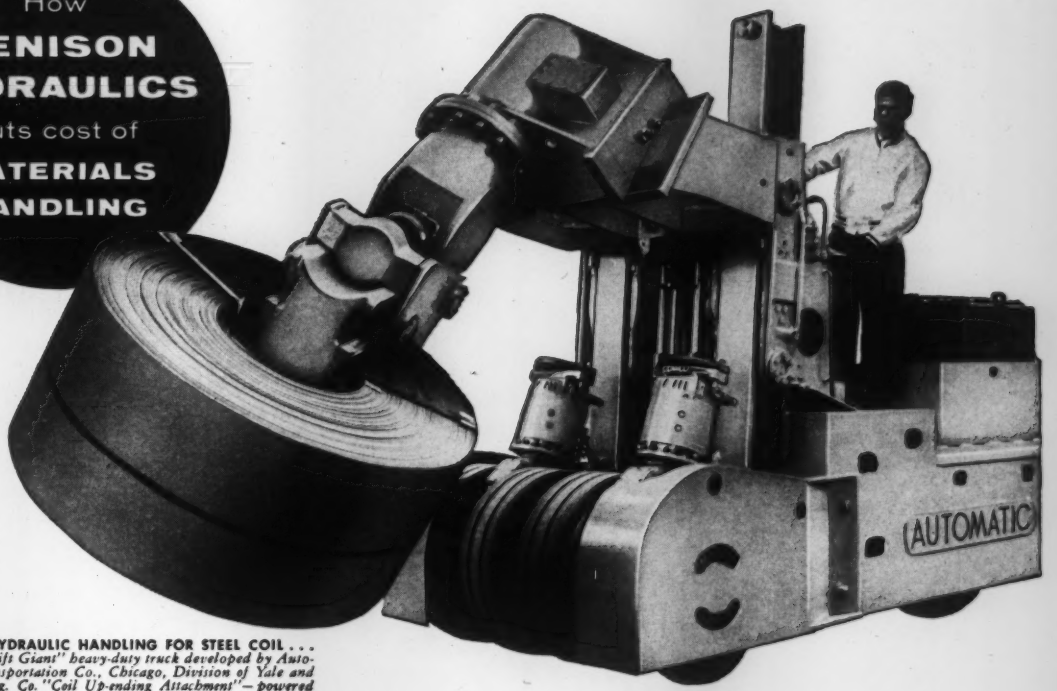
★Snap-Tite

ST-59-04

UNION CITY 11, PA.

Circle 465 on Page 19

How
DENISON HYDRAULICS
cuts cost of
MATERIALS HANDLING



SPEEDY HYDRAULIC HANDLING FOR STEEL COIL . . . *on a "Skylift Giant" heavy-duty truck developed by Automatic Transportation Co., Chicago, Division of Yale and Towne Mfg. Co. "Coil Up-ending Attachment"— powered by Denison Axial Piston Pumps — handles 10 to 40-ton loads of steel coil.*

AUTOMATIC® trucks handle steel coil like a baby . . . faster, safer with **DENISON** hydraulic power

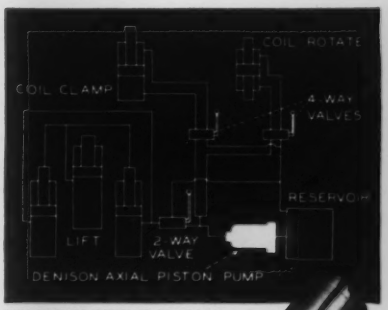
HERE'S the business end of a "Skylift Giant" industrial truck—equipped with a special "Coil Up-ending Attachment". Its jaws easily heft rolls of coiled steel weighing from 10 to 40 tons . . . *with Denison hydraulic power that pays off in smoother, faster, safer handling.*

In leading mills—these heavy-duty trucks speed handling and storage without damaging coils. The Coil Up-ending Attachment is designed to enter the coil's inside diameter with a fixed ram . . . while the outside is gripped by a powerful hydraulic clamp. This clamp-and-ram design prevents "telescoping" of coils during handling.

Three hydraulic cylinders—powered by motor-driven Denison 3000 psi Axial Piston Pumps — furnish lifting and clamping power. All three cylinders are connected hydraulically in parallel which results in a telescopic-cylinder action—but has the added advantage of retaining equal force and speed throughout the stroke at constant pressure and delivery.

Result: operator easily controls lowering speed at any level . . . and can inch the load up from extremely slow speed to maximum for which the flow control is set. *Safe, fast, smooth hydraulic control helps keep "Skylift" trucks continuously on the job . . . handling extra payload.*

Here's the kind of job your Denison Hydraulic Specialist can help *you* do *now*. Call him in soon . . . see how Denison hydraulic power can help put *more payload* into *your equipment*. Write us for details.



HYDRAULIC CIRCUIT DIAGRAM . . . *illustrates system for powering "Coil Up-ending Attachment". Denison equipment delivers hydraulic lifting and clamping power.*

DENISON 3000 PSI AXIAL PISTON PUMP

DENISON ENGINEERING DIVISION
American Brake Shoe Co.
1240 Dublin Road • Columbus 16, Ohio

DENISON STOCKING BRANCH OFFICES

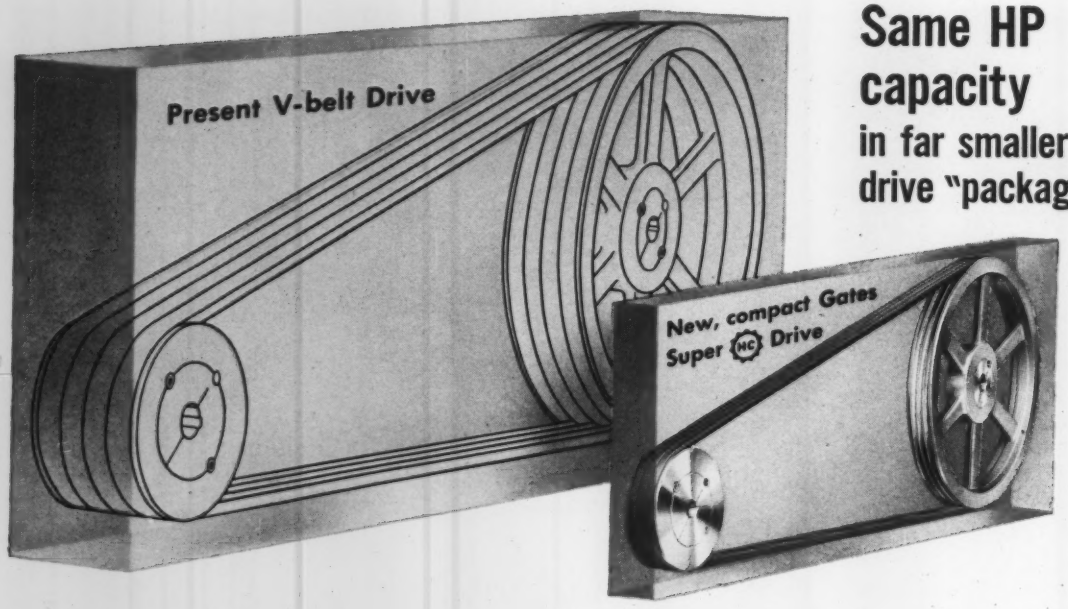
- LOS ANGELES (Hawthorne)
- CHICAGO
- DETROIT (Birmingham)
- ATLANTA
- HOUSTON
- NEWARK (Clark)
- CLEVELAND
- COLUMBUS (Home Office)

Denison and Denison HydrOILics are registered trademarks of Denison Eng. Div., ABSCO

DENISON HydrOILics

HYDRAULIC PRESSES • PUMPS • MOTORS • CONTROLS

Circle 466 on Page 19



Same HP capacity in far smaller drive "package"

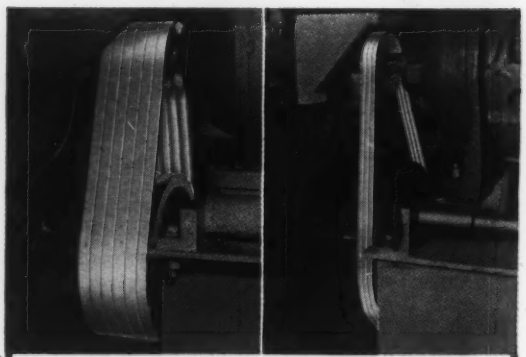
New high capacity V-belt cuts drive cost as much as 20%

Reduce size, cut costs! Gates new Super HC V-Belt Drive puts power transmission in a smaller package—cuts costs all along the line!

With Gates Super HC V-Belt Drives you use fewer belts, smaller sheaves. Sheave diameters and widths are reduced 30% to 50%; center distances 20% and more; weight is substantially reduced. *Initial drive cost is cut as much as 20%.*

Furthermore, as every designer knows, a more compact drive insures other savings, too. Smaller housings, bearings, bases and other components cost less; machining time is often reduced; shipping costs are lowered. And finally, the ultimate user gets the benefit of lower *maintenance* costs—less down time!

"The Modern Way to Design Multiple V-Belt Drives" is an informative handbook on Gates major advance in power transmission—the Super HC V-Belt Drive. Your nearby Gates Distributor—listed under Belts or Belting in your phone book Yellow Pages—will be glad to furnish a copy of this handbook.



BEFORE ◄ AFTER ◄

COMPARE: Conventional drive at left was replaced with Gates new Super HC V-Belt Drive at right. Three of Gates new, narrow HC V-Belts do the work of the former 6 standard width belts. In this application the new drive actually takes *one-third* the space of old!

TPA 391

Gates

World's Largest Maker of V-Belts

The Gates Rubber Company • Denver, Colorado
Gates Rubber of Canada Ltd., Brantford, Ontario

Gates Super HC V-Belt Drives

EXPANSIVITY

How Lukens *Application Research* can help you find the right steel plate for the job

In solving problems of expansivity, the experience of our Application Engineering staff is long and varied. And it's yours for the asking.

For example, a growing number of bridges expand and contract on *bearing plates* of Lukens stainless-clad steel. Extensive research led to the first such application. Tests run jointly with a consulting firm and a large university put Lukens clad steel plate through 2 million passes under a 100,000 pound loading—without harm. There was actually evidence that the bond between the backing steel and its stainless cladding grows stronger.

All the safety factors of corrosion-resistant stainless are present in stainless-clad—at significantly lower cost than 100% high alloy.

Since this initial research, many such bearing plate applications have been made—and their performance compared with that of other materials. Today, The Walt Whitman, Greater New Orleans, Rappahannock River, Throggs Neck, and a number of smaller highway bridges, are cradled on these safe, money-saving plates. The knowledge accumulated by Lukens' Application Engineers in this area and others is available to help guide you in your design problems.

That's why we say, *if your assignment is expansivity, let it be our assignment too.* Contact Manager, Application Engineering, E109 Services Building, Lukens Steel Company, Coatesville, Pa.

Helping Industry Choose Steels That Fit The Job

LUKENS

ASK FOR THE BULLETIN ON BRIDGE BEARING PLATES

Circle 468 on Page 19

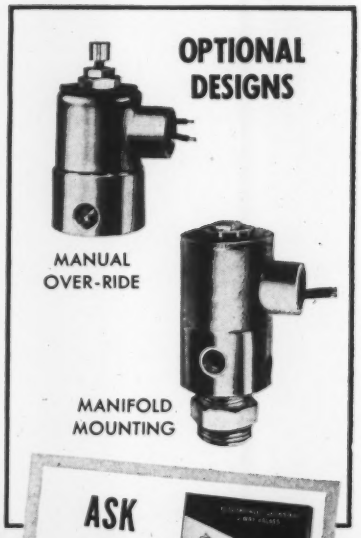
NEW SOLENOID VALVES *by* Airmatic

These corrosion-proof valves have only one internal moving part and a completely protected solenoid coil. The coil is fully sealed from air, oil, gas and water . . . and will not overheat on continuous duty. Coils for continuous or intermittent duty, a-c or d-c, are interchangeable.

Life expectancy is many millions of cycles and by renewing the one-piece valve plunger, many millions more can be expected. The plunger can be replaced without disturbing rigid piping.

DISTRIBUTORSHIPS FOR THESE NEW VALVES ARE AVAILABLE

SPECIFICATIONS		
	TWO-WAY	THREE-WAY
CATALOG NO.	91011	91011
PRESSURE RANGE	1/16" ORIFICE: 0-500 PSI 3/16" ORIFICE: 0- 70 PSI	1/8" ORIFICE: 0-300 PSI 3/16" ORIFICE: 0-100 PSI
ORIFICES	1/16" THROUGH 3/16"	1/8" AND 3/16"
VOLTAGE	MOST A-C AND D-C	MOST A-C AND D-C
DUTY	CONTINUOUS	CONTINUOUS
POWER CONSUMPTION	10 - 20 WATTS	10 - 20 WATTS
HEAT RISE	WITHIN UL LIMITS	WITHIN UL LIMITS



ASK FOR CATALOG

All valve deliveries are made from stock.

AIRMATIC VALVE, Inc.

7313 Associate Avenue • Cleveland 9, Ohio

EVERYTHING UNDER CONTROL

Phone: WOodbine 1-5320 • WESTERN UNION: Airmatic Valve, Inc., FAX, Cleveland, Ohio

Circle 469 on Page 19

News! The best features of
modern bearing design combined and refined in

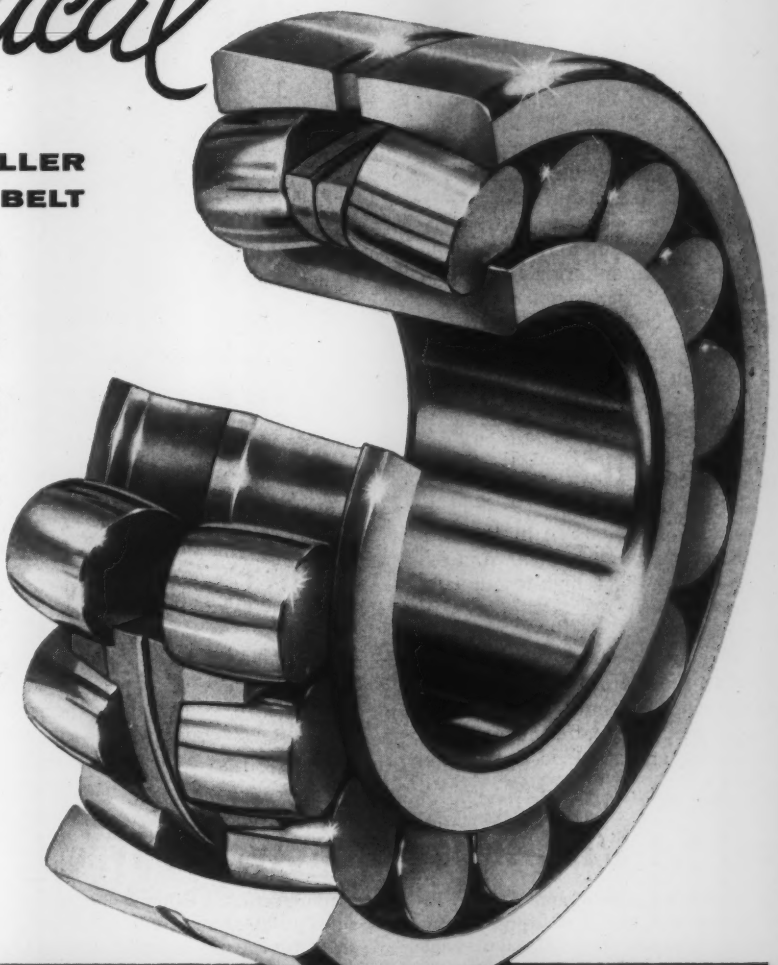
Spherical

SELF-ALIGNING ROLLER BEARINGS BY LINK-BELT

BIG, mirror-smooth convex rollers *plus* heavy, broad-shouldered inner race *plus* centrifugally-cast bronze, precision-machined retainers! Only from Link-Belt do you get ALL that is best in modern bearing design.

Individually, these elements represent major improvements on accepted design concepts. Collectively, they constitute the most efficient spherical roller bearings available . . . promise unequalled economies, whatever the application.

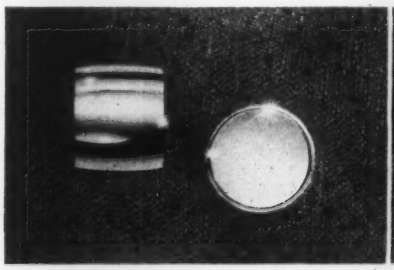
Your Link-Belt office will gladly explain the many performance advantages evolved with this new design. It can furnish full data on industry's most complete line of ball and roller bearings . . . pillow blocks and flanged, flanged-cartridge, cartridge, and take-up blocks.



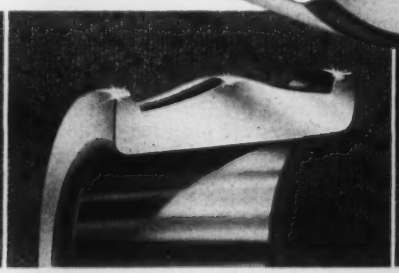
LINK-BELT

MANUFACTURERS OF SELF-ALIGNING BALL AND ROLLER BEARINGS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. Plants, Sales Offices and Distributors in All Principal Cities. 14,819-A



BIG, HIGHEST-CAPACITY ROLLERS. Each bearing has a maximum number of rollers—as large as possible, yet all components are in optimum balance.



HIGH, HEAVY INNER RACE FLANGES present convenient hold for assembly and removal of bearing without cutting away shaft, avoid any need to skimp on shaft shoulders.

PRECISION-MACHINED, CENTRIFUGALLY-CAST BRONZE RETAINERS have many times more support and ability to withstand high stress. They are not stampings. Design assures maximum bearing efficiency.

NEW running time meters register from 1/10 second to 99,999 hours

The new Cramer Type 632 running time meters, or time-totalizers, offer a simple, accurate means of recording elapsed time in many industrial or laboratory operations. They are applied to forecast the need for repair or servicing of equipment, to record total operating time or down time, and to supply time data for checking the operating performance of any circuit, machine, or electrically-powered system. Direct current and 400-cycle alternating current units, available in limited time ranges, fulfill the need for monitoring laboratory, military and experimental equipment where portability is often important.

TYPE 632

Also available with standard round dial

Operation

A Cramer constant-speed motor drives a precision drum-type counter when power is applied to the motor circuit. From the instant the motor circuit is closed, elapsed time is recorded on the counter, in the total ranges and unit counts shown in the table below. The high-torque and instant start-stop characteristics of the motor assure reliable accuracy at all counter speeds. Control circuits to the motor can be arranged to operate the counter during equipment running time, during idle time, or during any specified operational phase.

Features

TIME RANGES — 9,999.9 seconds to 99,999 hours (see Table).

MOTOR RATINGS — 115 or 220v ac, 60, 50, and 25 cycles. In limited time ranges, motors are available for 115v 400-cycle ac, or for specified voltages between 6 and 32v dc.

RESET — optionally available, in all time ranges.

DIALS — Chinese square (illustrated), or standard round.

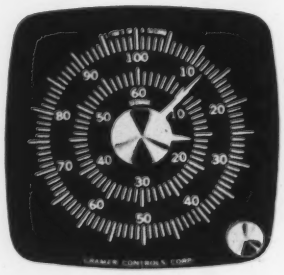
MIL-SPEC UNITS — available in hermetically sealed construction, to meet applicable specifications of MIL-E-5272A.

TYPE 632 TIME RANGES

COUNTS	TOTAL
1/10 sec.	9999.9 sec.
1 sec.	99999 sec.
1/100 min.	999.99 min.
1/10 min.	9999.9 min.
1 min.	99999 min.
1/10 hr.	9999.9 hr.
1 hr.	99999 hr.

and for 1/100-second accuracy, the Type 691 precision stop clock

In scientific research, and in many industrial and military applications requiring extremely precise time totalizing, Cramer Type 691 performs the same basic function as Type 632 but with still greater accuracy and flexibility. Total time ranges are either 60 minutes or 60 seconds. The inner scale on the dial reads directly in minutes or seconds. The outer scale reads either seconds or .01 minute for the 60-minute units, or .01 second for the 60-second unit. Reset is electrical, in 1/10 second, actuated either remotely or by a dial pushbutton. Motors, clutches and solenoids are available for all standard ac voltages and frequencies, and for 28 volts dc. One or two load switches (SPDT) are optionally available, for 5 amps at 115 and 230 volts ac or 2 amps at 28 volts dc. For load-switch operation, cams are precision cut to exact user specifications. Military units are available in hermetically sealed cases, to meet vibration, shock and other requirements of MIL-E-5272A.



TYPE 691

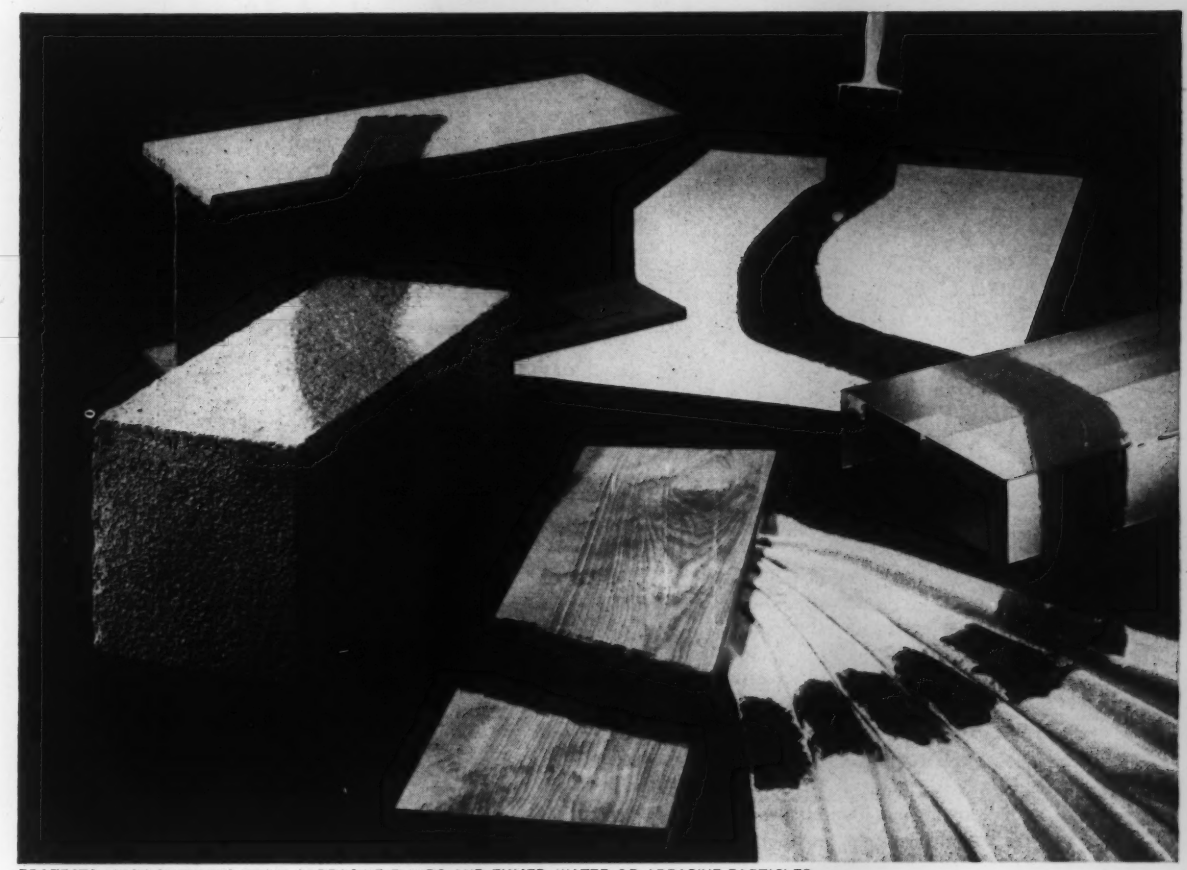
CRAMER CONTROLS
CORPORATION
Box 6, Centerbrook, Connecticut

Circle 471 on Page 19

NEWEST WEAPON IN THE WAR AGAINST CORROSION AND ABRASION!

Coro-Gard® 1706

BRAND PROTECTIVE COATING



PROTECTS MOST SURFACES FROM CORROSIVE FLUIDS AND FUMES, WATER OR ABRASIVE PARTICLES

From the Research Laboratories of 3M comes a remarkable new coating to fight corrosion—CORO-GARD 1706 Brand Protective Coating. This neoprene rubber based coating air-cures to a tough, rubbery, protective film with exceptional resistance to corrosive fluids and fumes, water and abrasion. It maintains exceptional adhesion, flexibility, corrosion and abrasion resistance even after these strenuous test conditions: 2000-hour salt-spray attack; 20 weeks' submersion in 20% solution of hydrochloric acid; six-month weather exposure in Miami, Florida.

CORO-GARD 1706 Coating speeds production, provides unusually high coverage to cut costs. It brushes as easily as paint, is self-priming, yet goes on vertical surfaces with minimum sagging. For steel, aluminum, wood, concrete, cloth and some plastics—wherever corrosion or abrasion must be fought—specify new CORO-GARD 1706 Coating. It provides maximum protection at low cost.

For complete performance data without obligation, write today on your company letterhead to: AC&S Division, 3M Company, Dept. SAR-109, St. Paul 6, Minn.

"Coro-Gard" is a reg. TM of 3M Co.

ADHESIVES, COATINGS AND SEALERS DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY

. . . WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

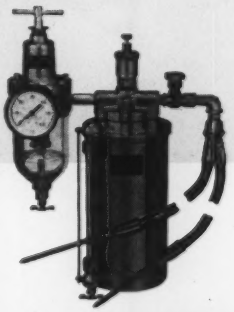
Circle 472 on Page 19

...with

Norgren SPRAY-LUBE UNITS

for single or dual point applications on tapping, drilling, milling, and grinding operations.

- LESS MACHINE DOWN-TIME
- INCREASED TOOL LIFE
- BETTER FINISHES



Lubrication Exactly Where Needed

Norgren Spray-Lube applies a fine spray of coolant directly to the tool or cutting area—at the location that provides the most efficient lubrication and cooling action.

Faster Cooling Speeds Production

A few ounces of sprayed coolant extracts more heat from the tool than gallons of the same fluid flooded over the workpiece and tool. Cutting, tapping, and grinding can be faster—output is increased—tool maintenance costs are reduced.

Reduced Coolant Consumption

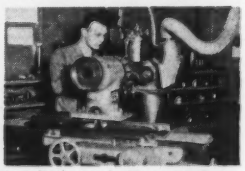
With fine spray, less coolant does a better job of cooling and lubricating—cuts costs.

Better Working Conditions

No messy pools of liquid on machine or floor. Unobstructed view of work. No splashing of liquid. Machine easier to clean. Machined parts cleaner to handle.

A Norgren Spray Lube System eliminates fusion of aluminum chips to milling cutter.

Norgren Spray Lube System delivers a fine, cooling spray that reduces wheel wear. Permits full view of workpiece.



Installation of Norgren Spray Lube System ended cracking of carbide-tipped cutters during sharpening—diamond wheels last twice as long.

If it's Norgren...It's Dependable.

For complete information about Norgren SPRAY-LUBE, call the nearby Norgren Representative listed in your telephone directory—or WRITE FACTORY FOR COMPLETE INFORMATION.

C. A. NORGREN CO.

3442 SOUTH ELATI STREET ENGLEWOOD, COLORADO

Circle 473 on Page 19

New Type AVR static-powered adjustable-speed drive

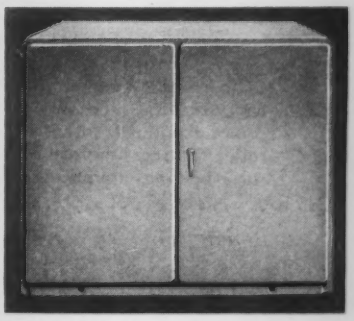
With the new Westinghouse static-powered AVR adjustable-speed drive, maintenance costs are virtually a thing of the past. Power magnetic amplifiers replace the conventional motor-generator set . . . there are no moving parts to weaken from wear and fail . . . you enjoy all the proven benefits of static control components.

Providing smooth, stepless speed control, new AVR drives are designed for use with motors from 1 to 200 hp . . . give you constant torque over an 8 to 1 speed range, or 10 to 1 with modification . . . are also available with constant-horsepower speed ranges.

New Westinghouse AVR drives are completely engineered, assembled and factory tested. They provide higher operating efficiency with greater reliability than heretofore obtainable from conventional drives. They simplify installation and reduce floor space required . . . sometimes as much as one-half the area of conventional M-G set drives.

Ask your Westinghouse sales engineer to show you exactly where and how you can benefit from new Westinghouse adjustable-speed drives. Or, write Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pennsylvania. J-22144

Also available . . . the standard Westinghouse AV drive with motor-generator type conversion.



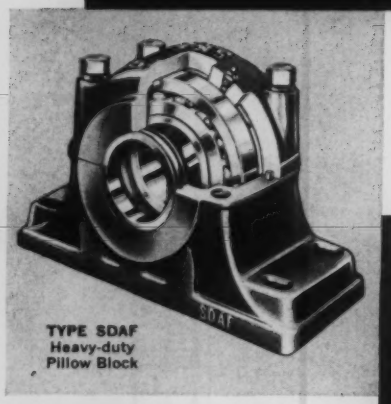
YOU CAN BE SURE...IF IT'S Westinghouse

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV FRIDAYS

Circle 474 on Page 19

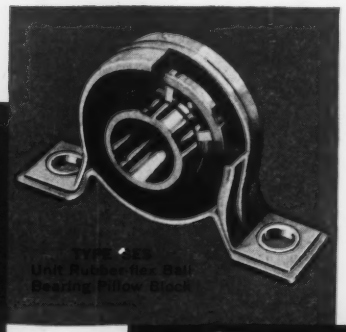
TYPE SAF
Ball or Spherical Roller
Bearing Pillow Block

Can you get these "special" qualities in "standard" pillow blocks?

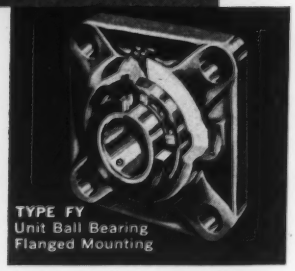


TYPE SDAF
Heavy-duty
Pillow Block

TYPE SY
Unit Ball Bearing
Pillow Block



TYPE ES
Unit Rubberflex Ball
Bearing Pillow Block



TYPE FY
Unit Ball Bearing
Flanged Mounting

Most pillow blocks offer easy assembly and rugged housings. But can they offer you low friction, self-aligning bearing operation and efficient sealing as well?

They can—if they're the SKF pillow blocks, and flanged mounting, shown here. Type SAF, for example, comes equipped with low-friction ball or spherical roller bearings that are *inherently* self aligning. And these bearings are effectively protected by Triple-Seal rotating rings. Abrasives and corrosives can't get to them—oil or grease can't drip out.

Yet this is a standard SKF pillow block, that is competitively priced in spite of its combination of extra features. We make it for shaft sizes from ¾" to 10½", for mounting directly or with an adapter. A cast steel housing (SAFS) is available for heavy duty applications.

For details, call one of our twenty-four offices. 5938

Spherical, Cylindrical, Ball, "Tyson" Tapered and REED Miniature Bearings

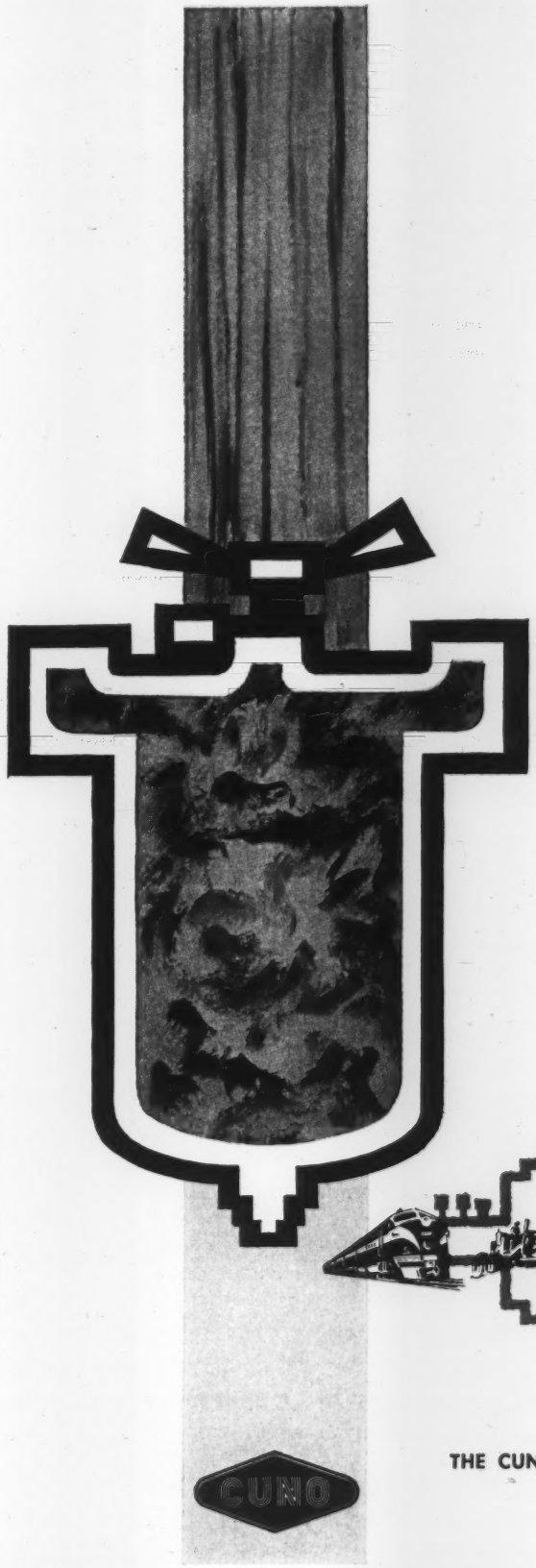
EVERY TYPE—EVERY USE

SKF®

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.

*REG. U.S. PAT. OFF.

Circle 475 on Page 19

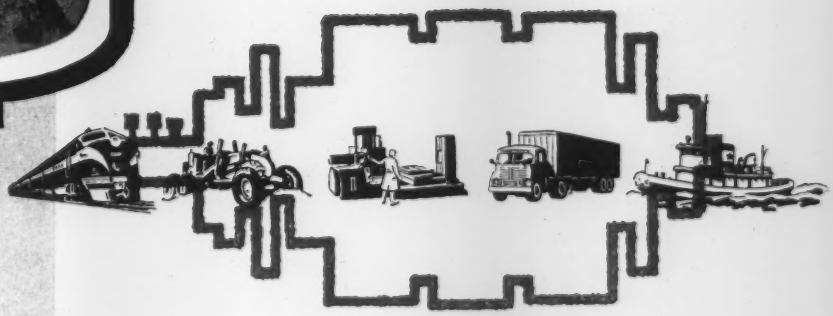


whatever the **power production application...** you can depend on **CUNO** engineered filtration

"The more complete the filtration, the more efficient the production of power." Cuno filters remove damaging contaminates and reduce costly stoppages.

To meet the specific requirements of *your* power production application, Cuno provides effective, engineered filtration with . . . Auto-Klean Self-Cleaning Edge-Type, Flo-Klean Automatic Self-Cleaning Wire Wound, Micro-Klean Disposable Depth Cartridge . . . available in a variety of housings.

Let us apply over 30 years of filtration know-how to *your* requirements.



THE CUNO ENGINEERING CORP., DEPT. 12, MERIDEN, CONN.

A Leader in Industrial Filtration for More Than 30 Years

Sales Offices throughout the United States and Canada

In Canada write: Peacock Bros., Ltd., P.O. Box 1040, Montreal 3, P.Q.

Circle 476 on Page 19

LOW SECONDARY LABOR CONTENT

Thin sections, holes, bosses, metal savers, odd shapes all produced in a split second—from molten metal. No other process can compete with this for eye appeal or low cost.

with MADISON-KIPP zinc and aluminum die castings

When product designers send preliminary drawings for critical review by the seasoned Madison-Kipp mechanics, it has often proved to be the decisive factor in the ultimate design of the component parts.

The original designer thoroughly understands the function of his product. We thoroughly understand die casting and machining problems. Combining the two skills at an early period of development is logical and valuable.

Our customers of long standing always utilize this system which virtually pyramids design talent for successful high production manufacturing, with low secondary labor content.

Please clip this ad as a reminder to contact us when you have die casting requirements.

kipp

MADISON-KIPP CORPORATION
210 WAUBESA STREET • MADISON 10, WIS., U.S.A.

RESEARCH PARTICIPANT

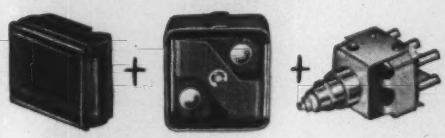
- Skilled in Die Casting Mechanics
- Experienced in Lubrication Engineering
- Originators of Really High Speed Air Tools

for: MISSILE, ELECTRONIC and INDUSTRIAL CONTROLS

NEW ELECTRO SNAP modular mounting lighted push-button panel switch

Simplifies Control Panels; Saves Space, Cuts Cost. May be used singly or in "stacked" arrangement.

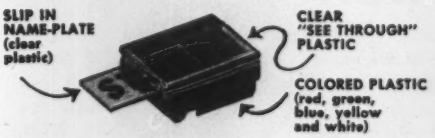
3 UNITS IN 1 COMPACT MOUNTING



NAME-PLATE + PILOT-LIGHTS + PUSH-BUTTON SWITCH UNIT

In one compact assembly, this unit provides new space and cost economy whether used individually or in "stacked" arrangement. You get quality appearance with "thumb-size" operation.

TWO-PIECE, PLASTIC NAME-PLATE PROVIDES EASY COLOR-CODING; SIMPLIFIES OPERATION IDENTIFICATION



Virtually any operating condition can be identified with this push-button name-plate arrangement. The snap-in button is easily removed for insertion of slip-in name-plate. Use of various colored button bases, or various colored lamps, permits wide range of codings and monitoring.

This new Electro-Snap push-button panel switch efficiently combines a name plate, pilot light assembly and a switching unit in one compact modular assembly. The trim, streamlined design permits easy "stacking" on control panels or consoles. It eliminates congestion by replacing three individual units (nameplate, pilot light assembly and switch unit). You can achieve greater operating efficiency and quality appearance while making substantial savings in space and cost. A wide variety of configurations is available in:

- **circuit arrangements of switch and pilot lights**
- **colored buttons for color coding**
- **colored lights for color monitoring**

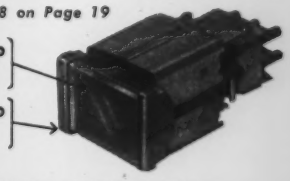
The operating and indicating combinations possible through the variation of arrangements provides almost unlimited applications for sequencing, movement-limit, start-and-stop, position-indicating and similar control operations.

Check the design and construction advantages of this significant advance in panel switches for your own applications. For further details contact your local representative or write to:

ELECTROSNAP CORPORATION
4214 W. Lake St. • Chicago 24, Ill.
VA 6-3100 TWX #CG-1400

Circle 478 on Page 19

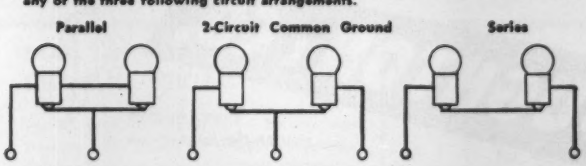
- **Snap-in button permits easy lamp replacement from front of panel**
- **Barrier can be color-anodized to your specification**



The lighted push-button switch assembly is also available without the switch unit for use where only pilot light duty is required.

VARIETY OF CIRCUIT ARRANGEMENTS PERMITS WIDE RANGE OF INDICATING AND SWITCHING COMBINATIONS

- **Lamp circuit can be wired independently of switch circuit—or through switch unit.**
- **Since two lamps are provided, independent external circuits can be indicated on single unit with different lamp colors and white push-button.**
- **Complete push-button switch unit or pilot-light assembly can be supplied in any of the three following circuit arrangements.**

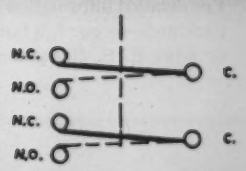


- **6V. or 28V. lamps may be used (solder terminals on lamp assembly)**

Switch terminals available
- **Solder**
- **Turret**
- **Double Turret**
- **AMP quick-disconnect**

Switching Circuits to Meet Your Needs

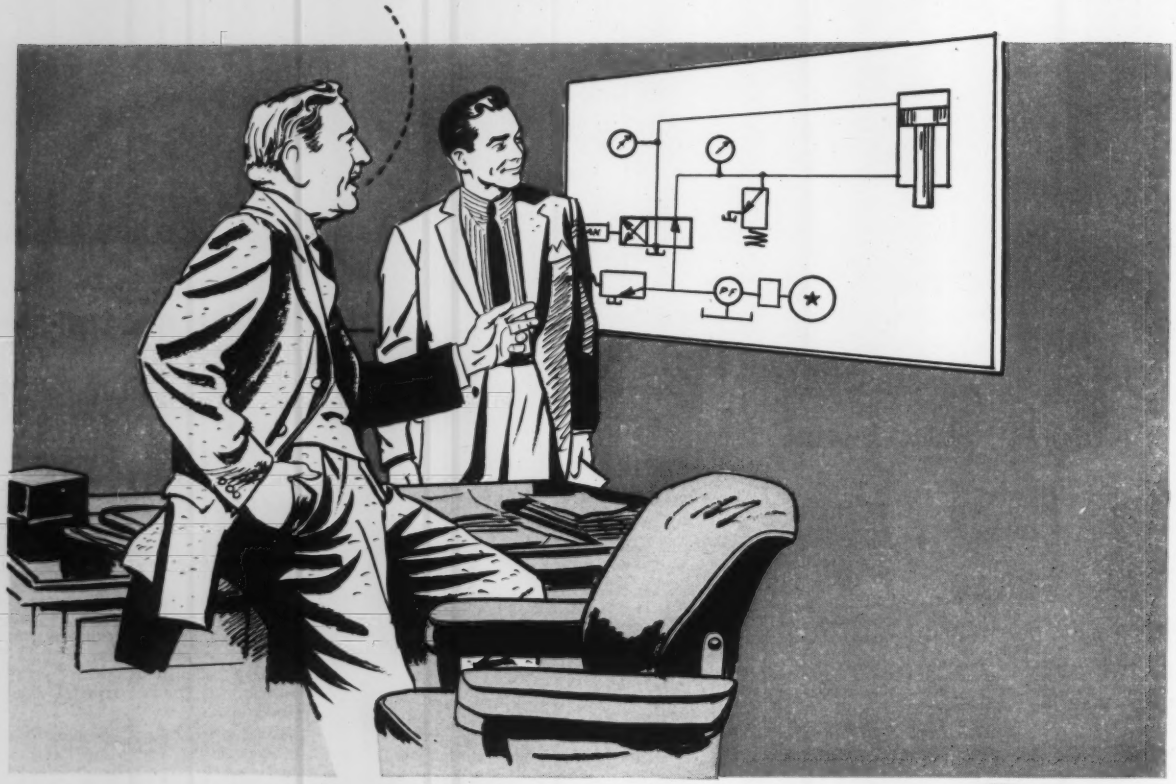
The double-pole, double-throw switching unit may be wired normally-open or normally-closed.



a standard ELECTRO-SNAP UNIT

- Compact
- Space Saving
- Precision-Engineered
- Low Cost

"How do you know the packings will be compatible with that hydraulic fluid?"



There's only one fast, safe answer!

HOUGHTON
THE ONLY COMPLETE LINE OF
PACKINGS & FLUIDS
FOR ANY INDUSTRIAL HYDRAULIC SYSTEM

Ask Houghton—the one manufacturer who designs, formulates and produces *all types of packings* and *all types of fluids*. Since Houghton can offer you any type of hydraulic packing in any material, the answer is completely unbiased.

"V" PACKINGS—a design plus! Houghton "V" packings of VIM leather and VIX-SYN homogeneous or fabricated rubber all have an identical stack height. This permits complete interchangeability, or mixing of "V's" within a set, without engineering changes.

"U" PACKINGS—available in all standard sizes. Cross-section meets JIC and AN Specifications. In VIM wax or rubber-impregnated leather . . . or VIX-SYN homogeneous synthetic rubber U-Cups.

CUPS—with pre-formed square shoulders, flared side walls, maintaining a pre-load on the lip. In VIM exclusive rubber-impregnated leather . . . VIX-SYN fabricated synthetic rubber.

"O" RINGS—Houghton's large stock and fast delivery make it a preferred source for standard sizes. Specials on request.

For detailed information about Houghton's complete line of compatible hydraulic packings—or our full family of hydraulic fluids—call your Houghton Man today, or write E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33, Penna.

PACKINGS & FLUIDS

. . . products of

E. F. HOUGHTON & CO.

Ready to give you on-the-job service

Philadelphia, Pa. • Chicago, Ill. • Carrollton, Ga. Detroit, Mich. • San Francisco, Calif. • Toronto, Canada

Circle 479 on Page 19

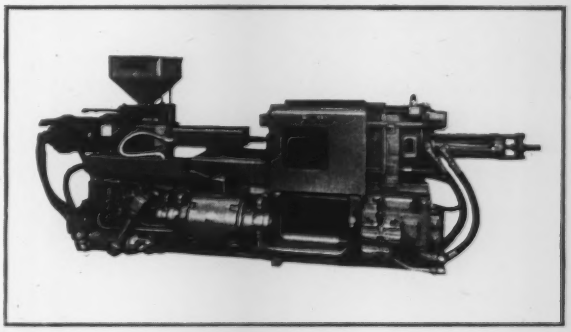
NOW! Let General Electric ECONO-MATCH Motors to Meet Your Specific Drive Requirements

You have over *three billion* different designs and types of integral hp a-c motors to choose from. And, it is increasingly difficult and costly to make this choice. It will pay you to find out how General Electric engineers can help you do this motor selection job.

THIS NEW MOTOR SELECTION SERVICE, ECONO-MATCHING, is the optimum matching of motor to machine and application for over-all economy, improved machine performance and greater reliability.

HOW ECONO-MATCHING WORKS—G-E engineers work closely with your designers studying machine characteristics: speed, torque, duty cycle, life expectancy, environmental conditions, etc. Then, through use of computers and advanced design techniques, General Electric can supply exactly the motor required for your job.

FOR EXAMPLE, the Reed-Prentice injection molding machine, shown at right, had been using a standard 40-hp motor. By ECONO-MATCHING, G-E engineers determined that a smaller, lighter, more compact 30-hp motor with improved electrical characteristics could do the job required. Although this special 30-hp motor cost slightly more than a standard 30-hp, it provided greater efficiency and cost considerably less than the 40-hp motor it replaced. It also cut space and weight requirements. G.E. has also ECONO-MATCHED motors for crane, compressor, and other applications.



GENERAL ELECTRIC

MAIL THE ATTACHED COUPON TODAY . . .

or call your nearby General Electric Apparatus Sales Office for complete information on how G-E can ECONO-MATCH a motor to meet your specific requirements.

Circle 480 on Page 19

Section F891-21A
GENERAL ELECTRIC CO.
Schenectady, N. Y.

Please furnish more information on how you can ECONO-MATCH a motor for my application which is_____

NAME_____ TITLE_____

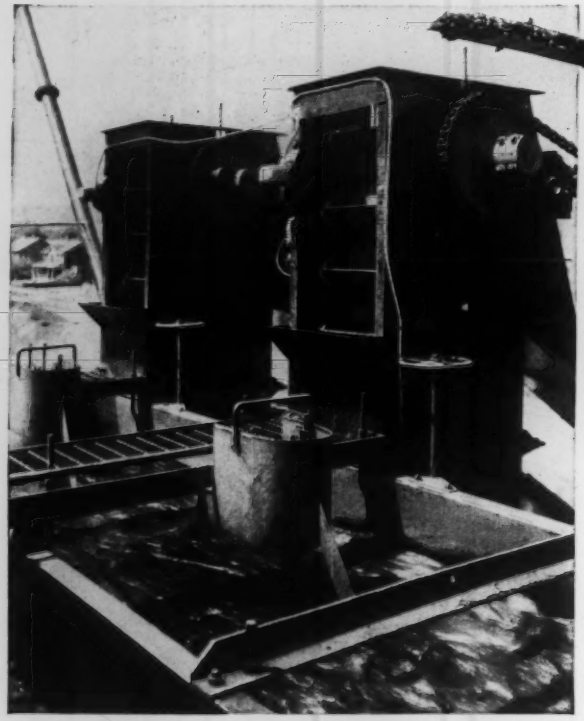
COMPANY_____

CITY, STATE_____

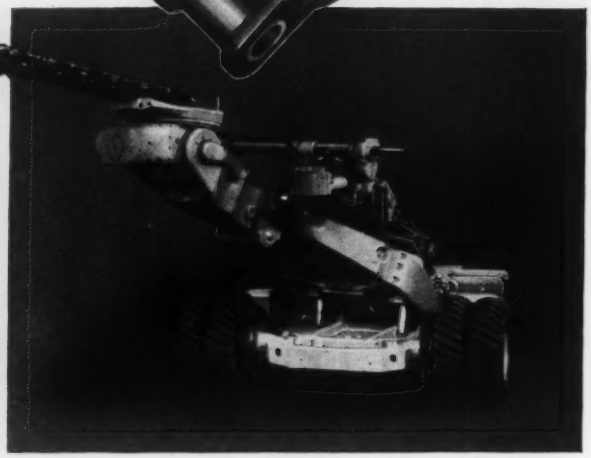
JEFFREY STR* CHAIN

has the reserve strength necessary for hard work and sudden overloads

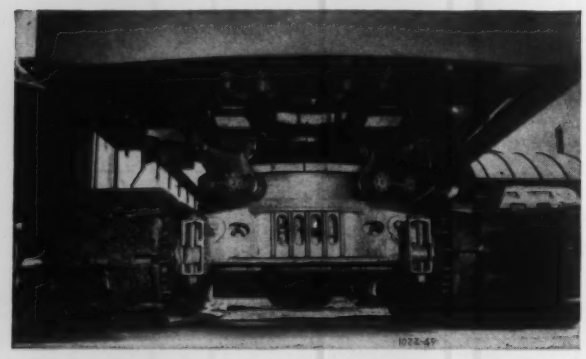
*Steel Thimble Roller Chain



Jeffrey STR Chain on bucket elevator drive of cleaning jig.



Jeffrey STR Chain on traction wheels of large cutter.



Jeffrey STR Chain on crawler drive of power shovel.

YOU SEE MORE and more Jeffrey STR Chain every day. Jeffrey's own high-quality equipment uses Jeffrey STR for dozens of power transmission and conveying applications. Other manufacturers incorporate Jeffrey STR as original equipment on machines they make. And operators everywhere replace chain drives of whatever make with Jeffrey STR.

With Jeffrey STR you get a balanced chain design with maximum strength and minimum weight. Moreover you get the reserve strength so necessary for the hard work and sudden overloads common under full-scale operations.

For dependable, long-life chain for power transmission, conveying and elevating service, see your nearby Jeffrey distributor or district office, or write to The Jeffrey Manufacturing Company, Columbus 16, Ohio.

JEFFREY

CONVEYING • PROCESSING • MINING EQUIPMENT • TRANSMISSION MACHINERY • CONTRACT MANUFACTURING

UNIVERSAL ELECTRIC TYPE 118 FRACTIONAL HP MOTOR

*with new free-aligning Universal Bearing**

*PATENT APPLIED FOR

UNIVERSAL ELECTRIC announces a new, improved Type 118 four-pole, shaded pole motor featuring the NEW Free-aligning **Universal Bearing** that eliminates fractional hp motor bearing problems due to misalignment. With the axis of support in the center rather than at the end, and utilizing only the shaft itself for alignment, the new bearing is inherently in balance and can adjust to any shaft misalignment 100% of the time under any load conditions. The new bearing assembly provides longer bearing life, better lubrication . . . makes the Type 118 an easier starting motor that runs without a whisper of sound. More rugged and precision built from highest quality materials, the Type 118 is ideal for an unlimited number of applications that require maximum dependability with a minimum of maintenance, including kitchen ventilators, tape recorders, unit heaters, refrigeration equipment, window fans, record players, pump units, etc.

Write for complete information on the UNIVERSAL ELECTRIC Type 118 fractional H.P. motor and the new free-aligning **Universal Bearing.**

UNIVERSAL ELECTRIC COMPANY

PRECISION ELECTRIC MOTORS

EXECUTIVE AND GENERAL SALES OFFICES: OWOSSO, MICHIGAN, DEPT. 10

Circle 482 on Page 19

Since World War II designers of air and space craft have made ever-increasing use of honeycomb in a great variety of structural and non-structural applications. Honeycomb can be made from almost any material available in continuous web or roll form, e.g., aluminum, glass fabric, cotton, stainless steel, paper, asbestos, titanium. In its cellular configuration, honeycomb is 97% air, 3% material.

Honeycomb has intrinsic qualities of high strength, light weight, high ratio of surface area to volume and other specific properties which depend upon the type of material used. These combinations of properties, which have given honeycomb wide application in air and space craft, offer to designers in industry generally unique opportunities in product design.

In the interest of advancing this knowledge of honeycomb, Hexcel, through its research and development staff (the industry's largest), has prepared this informational series. Should you desire additional technical information, please complete the information request form on this page. Your request will receive immediate attention.

INFORMATION REQUEST

Send to Hexcel Products Inc. Dept. MR
2332 Fourth Street, Berkeley 10, California

NAME_____

TITLE_____

COMPANY_____

STREET_____

CITY_____ ZONE____ STATE_____

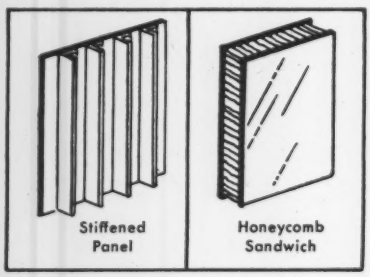
HEXCEL PRODUCTS INC.
World leader in honeycomb

Executive offices: 2332 Fourth St., Berkeley, California. Plants: Oakland and Berkeley, California; Havre de Grace, Maryland. Sales Offices: Inglewood, California; Fort Worth, Texas; Long Island City, New York.

HONEYCOMB SANDWICH PANELS

Strength/Weight Ratio

Traditional design of flat panel structures to resist bending or column loading has been to use either thick plates or thin sheets stiffened with angle extrusions to form a more or less rigid panel. Where end use of panel requires a high stiffness-to-weight ratio or a superior strength-to-weight ratio, many designers have turned to the use of sandwich structure.



Sketch #1

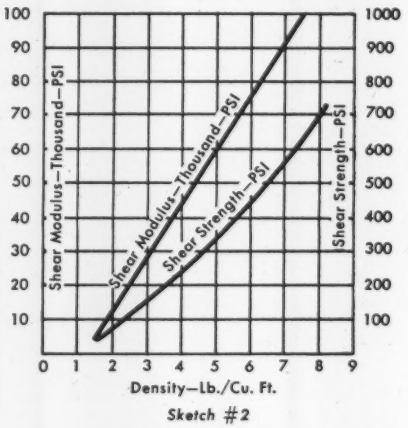
In a sandwich structure, the panel is made up of two faces with a light weight core material between them. In order to qualify as a structural sandwich, the core must be rigidly attached to the two faces. When these requirements are met, the resulting structure is capable of the highest strength-to-weight and rigidity-to-weight ratios presently obtainable by ordinary design methods.

Sandwich Structures:

A Design Approach

Sandwich structures are really a method of design approach rather than a single material. It is possible to design structures precisely tailored to fit the requirements at hand. Not only can the thickness and type of facing material be varied, but the thickness and density of the core material is subject to the designer's choice.

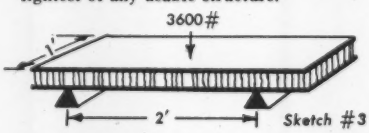
In the two curves shown, shear strength and shear modulus are given for Hexcel aluminum honeycomb in densities ranging from two to eight pounds per cubic foot. The strengths these core materials develop compare favorably with the strength of much heavier cores of plastic foam, wood fibers or other less efficient materials.



Sketch #2

Bending Loads

Bending strength and the bending rigidity of sandwich panels are two primary reasons for their broad acceptance in the area of light weight structures. In comparing panels loaded as shown in the sketch below, it can be shown that honeycomb sandwich is by far the lightest of any usable structure.



Sketch #3

3600 LB. WEIGHT - - - - - 24" SPAN

Material	Deflection (in inches)	Weight (in pounds)
Honeycomb Sandwich	.058	7.79
Nested "I" Beams	.058	10.86
Steel Angles	.058	25.9
Aluminum Plate	.058	34.2
Magnesium Plate	.058	26.0
Steel Plate	.058	68.6
Glass Reinforced Plastic Laminate	.058	83.4

The list of weights and deflections in the above table gives a clear indication that honeycomb sandwich panels have broad areas of application.

Circle 483 on Page 19

AVOID the **HIGH COST** and difficulty of fabricating long, hard & straight parts by conventional methods . . .

THOMSON

60 Case

hardened and ground

SHAFTS, ROLLS, GUIDE RODS and other long-round parts

60 Case is the result of over ten years of experimental work and production experience with hardened and ground shafts which are a requirement for BALL BUSHINGS, the Linear Ball Bearing manufactured by Thomson Industries, Inc.

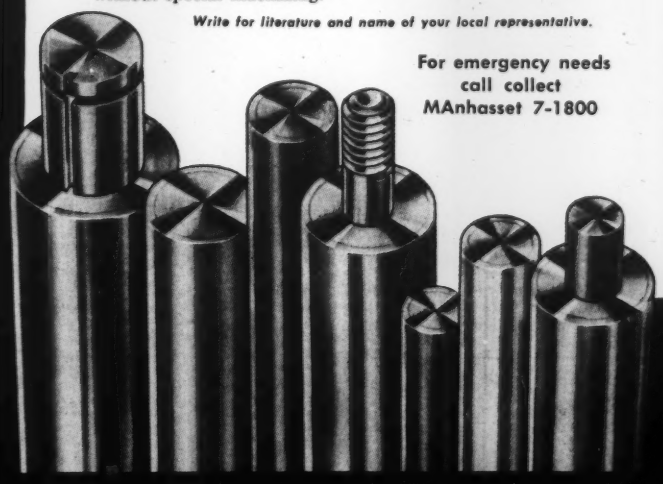
The special techniques and equipment that have been developed enable high production rates and low handling costs. This permits big savings over conventional methods which are plagued with erratic warpage, straightening and resultant grinding problems. Finished *60 Case* parts frequently cost less than the scrap losses that result from conventional methods.

60 Case material has a surface hardness close to 60 on the Rockwell C scale which is essential to resist wear.

Long lengths of material ranging in diameter from ¼" to 4" are stocked to enable prompt shipment of *60 Case* parts, with or without special machining.

Write for literature and name of your local representative.

For emergency needs
call collect
MAnhasset 7-1800



ADVANTAGES of *60 Case*

- COST REDUCTION
- HARD BEARING SURFACE
- ACCURATE DIAMETERS
- GROUND FINISH
- STRAIGHT PARTS
- DELIVERY FROM STOCK
- ADDED STRENGTH
- UNIFORM HIGH QUALITY

TYPICAL *60 Case* PARTS

GUIDE RODS, SHAFTING, ROLLS, TRAVERSE RAILS, PISTON RODS, ARBORS, LEADER PINS, TIE RODS, KING PINS, AXLES, CONTROL RODS, GUIDE POSTS, MANDRELS, BEARING ROLLERS, SPINDLES

THOMSON INDUSTRIES, Inc.
Dept. C-5, Manhasset, New York

Circle 484 on Page 19

HOW *Fulflo* FILTERS PROTECT YOUR AIR-OPERATED EQUIPMENT . . .

HONEYCOMB FILTER TUBE: Patented Honeycomb Filter Tubes minimize troublesome gumming — remove moisture, oil, microscopic dust, rust, dirt and scale.

POSITIVE SEAL: No unfiltered air can pass at either top or bottom.

ALUMINUM DEFLECTOR: Precipitates oil and moisture to sump.

STRENGTH: Sturdy steel shell is domed for extra strength.

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MACHINE DESIGN
October 1, 1959

The Shadow for the Substance

WHENEVER engineers' salaries are discussed, observers are likely to qualify their remarks by saying money isn't everything: Man does not live by bread alone. Supposedly status and prestige, and the inner satisfactions of a job well done, are part of the compensation of a well-adjusted engineer.

In *The Status Seekers,* Vance Packard observes that engineers, by and large, do not seem to be struggling as hard as some other groups to advance their status in the community. Why?

There's a clue in Mr. Packard's six "occupation prestige" factors:

1. Importance of task performed.
2. Authority and responsibility inherent in the job.
3. The knowledge required.
4. The brains required.
5. The dignity of the job.
6. The financial rewards.

On many of these factors, if not most, the engineer has a head start over other occupations represented in the community.

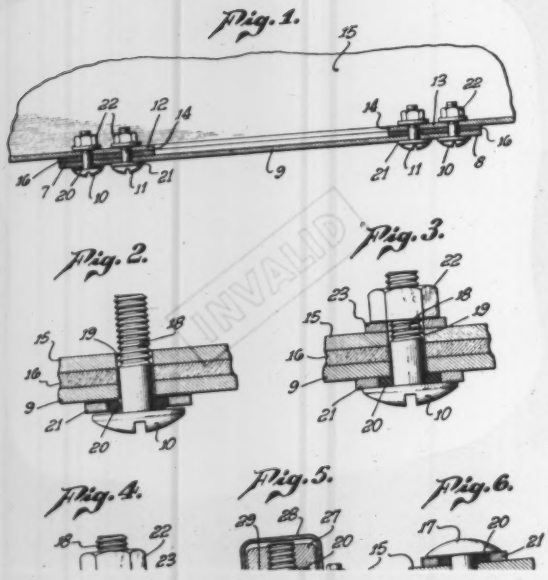
What of his prestige and status within his own profession? While the profession as a whole stands high in public esteem, the individual engineer is one in three-quarters of a million. As W. S. Gilbert put it: "When everyone is somebody, then no one's anybody."

We'd like to think that status within the profession is governed less by trappings than by performance. Isn't the professional musician judged by his performance rather than by the length of his hair?

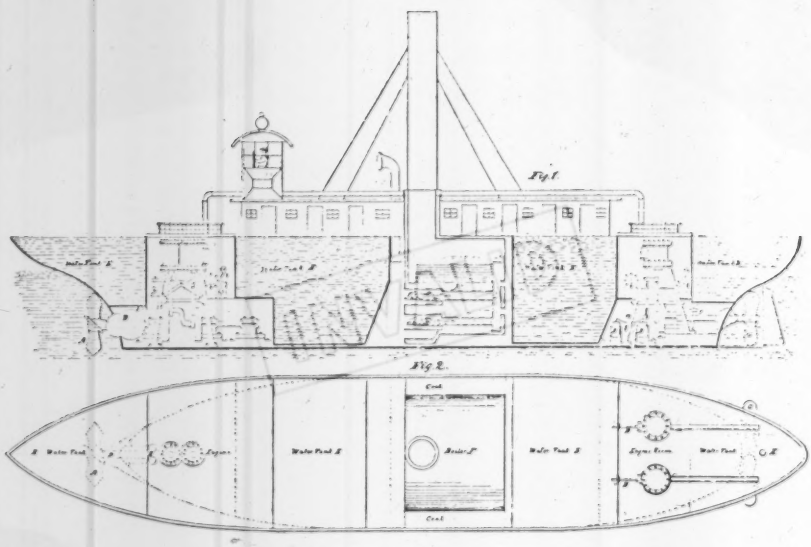
An engineer's colleagues, likewise, judge him by his useful accomplishments, not by any symbols of status that he may cultivate. They do not mistake the shadow for the substance.

Colin Carmichael

EDITOR



To be patentable, a device must be more than a mere improvement.



Top

Fastener sealing device developed and patented for use on integral aircraft fuel tanks. When a company undertook the manufacture of these devices without a subcontract, the patent owner brought suit for infringement. In the court action, the validity of the patent was challenged on the ground of lack of invention. This contention was upheld by the court because the patent claim failed to meet ". . . the definition of 'invention' as pronounced by the Supreme Court."

Early dredge-boat patent which was the subject of a famous decision by the U. S. Supreme Court. Issued in 1867, the patent was later declared invalid by the court for lack of invention. In its precedent-setting statement, the court declared ". . . It was never the object of these laws to grant a monopoly for every trifling device, every shadow of a shade of an idea. . . ."

Here are the rules followed by the courts in evaluating . . .

The Quality of Invention

ALBERT WOODRUFF GRAY
Forest Hills, N. Y.

FROM the seeming chaos of decisions dealing with the question of invention, one fact is apparent. Each situation is governed by its own features and surrounding circumstances. However, the general underlying principle followed by the courts was clearly set forth in a celebrated statement by the U. S. Supreme Court before the turn of the century.

In that famous decision,[1] the court said: "The design of the patent laws is to reward those who make some substantial discovery or invention, which adds to our knowledge and makes a step in advance in the useful arts. Such inventors are worthy of all favor. It was never the object of these laws to grant a monopoly for every trifling device, every shadow of a shade of an idea which would naturally and spontaneously occur to any skilled mechanic or operator in the ordinary progress of manufacture.

"Such an indiscriminate creation of exclusive privileges tends rather to obstruct than to stimulate invention. It creates a class of speculative schemers who make it their business to watch the advancing wave of improvements and gather its foam in the form of patented monopolies which enable them to lay a heavy tax upon the industry of the country without contributing anything to the real advancement of the arts. It embarrasses the honest pursuit of business with fears and apprehensions of concealed liens and unknown liabilities to lawsuits and vexatious accountings for profits made in good faith."

DURING World War II, a California aircraft manufacturer was assigned the urgent task of constructing integral fuel tanks in the PB2Y-3 aircraft. Until that time fuel had been placed in containers within the wings. This project was an effort to develop a proper fastener which would eliminate the

The constitution gives Congress the power

> To promote the progress of science and useful arts by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries.

Under that authority, the present patent law has been enacted. It provides,

> Whoever invents or discovers a new and useful process, machine, manufacture or composition of matter or any new and useful improvement thereof, may obtain a patent therefor.

For more than a century and a half, the courts have sought a clear definition of the phrase, "invents or discovers." Their elusive goal: To provide a well-defined boundary between inventions that fall within the sphere of the Federal Constitution and the patent statute and those that are mere mechanical improvements.

[1]References are tabulated at end of article.

container with a consequent saving in both space and weight.

In its performance of this task, the aircraft company had been issued a patent on a two-piece fastener. Later, the company to which the manufacture of these fasteners had been subcontracted, became dissatisfied. With the cancellation of the subcontract, it undertook the manufacture of these fasteners on its own and, according to the aircraft company, became an infringer of their patent.

Among the claims of this patent was the statement, "A washer of rigid material having a center bore surrounding the shank of the fastener and adapted to make rigid contact with the head of the fastener and a tank wall, and a rubber-like doughnut ring positioned within the bore of the washer, said ring having a diameter greater than the thickness of the washer, so that when pressure is applied, the ring is deformed into sealing contact with the bore of the washer, the shank, the head of the fastener and the continuous portion of the wall."

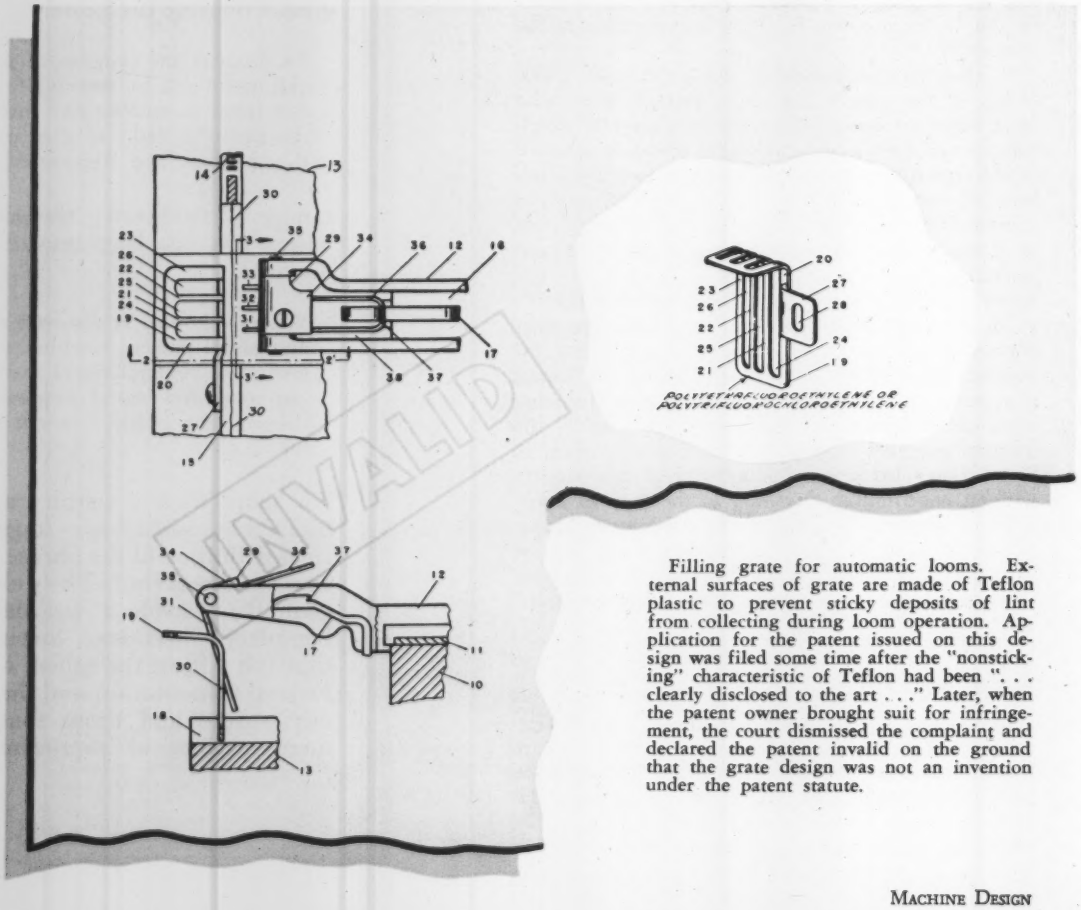
In its defense, the company charged with infringement argued that the patent was invalid, and that the discovery to which it applied was not an invention within the meaning of the patent statute. This contention was sustained by the federal court in California.[2]

"The claim states that the rubber-like doughnut shaped ring has a greater diameter than the thickness of the washer. It does not say how much greater —only greater. When there is a certain void to be filled that void can be ascertained either by mathematical calculation or by a trial and error method.

"We assume that mathematicians could take the area to be filled, the size of the shank, the head of the fastener and the walls and determine mathematically just how much rubber would be needed to fill the void. On the other hand, the amount of rubber required could be determined by a trial and error method.

"Thus we come to the question whether or not the determination of the amount of rubber to be used in the sealing ring, either by a mathematical calculation, or by trial and error, is invention. We are of the opinion that the claim lacks the definition of 'invention' as pronounced by the Supreme Court."

ONLY a few months later a similar situation came for review before the federal appellate court in Tennessee. Damages and an injunction were sought for the infringement of a patent on a "filling grate for looms."



Filling grate for automatic looms. External surfaces of grate are made of Teflon plastic to prevent sticky deposits of lint from collecting during loom operation. Application for the patent issued on this design was filed some time after the "nonsticking" characteristic of Teflon had been ". . . clearly disclosed to the art . . ." Later, when the patent owner brought suit for infringement, the court dismissed the complaint and declared the patent invalid on the ground that the grate design was not an invention under the patent statute.

Here, the patent claim was, "Said device comprising a grate and a pivoting fork having a number of tines designated to cooperate with said grate by pressing a filling yarn against the face of the grate, the fork thereby being pivoted to indicate the presence of said filling yarn and by passing said tine through the openings of said grate when any filling yarn is present, the fork thereby not being pivoted to indicate the absence of a filling yarn, the improvement which comprises a grate having external surfaces composed of a synthetic polymeric material selected from the group consisting of polytetrafluoroethylene and polytrifluorochloroethylene."

Shortly before this patent was granted, an article published in a trade magazine called attention to the problem of sticky deposits from looms and stated that encouraging results had been obtained with Teflon plastic.

Holding that the subject of this patent was not an invention within the statute and, hence, furnished no ground for maintaining an action for infringement, the federal appellate court said:[3]

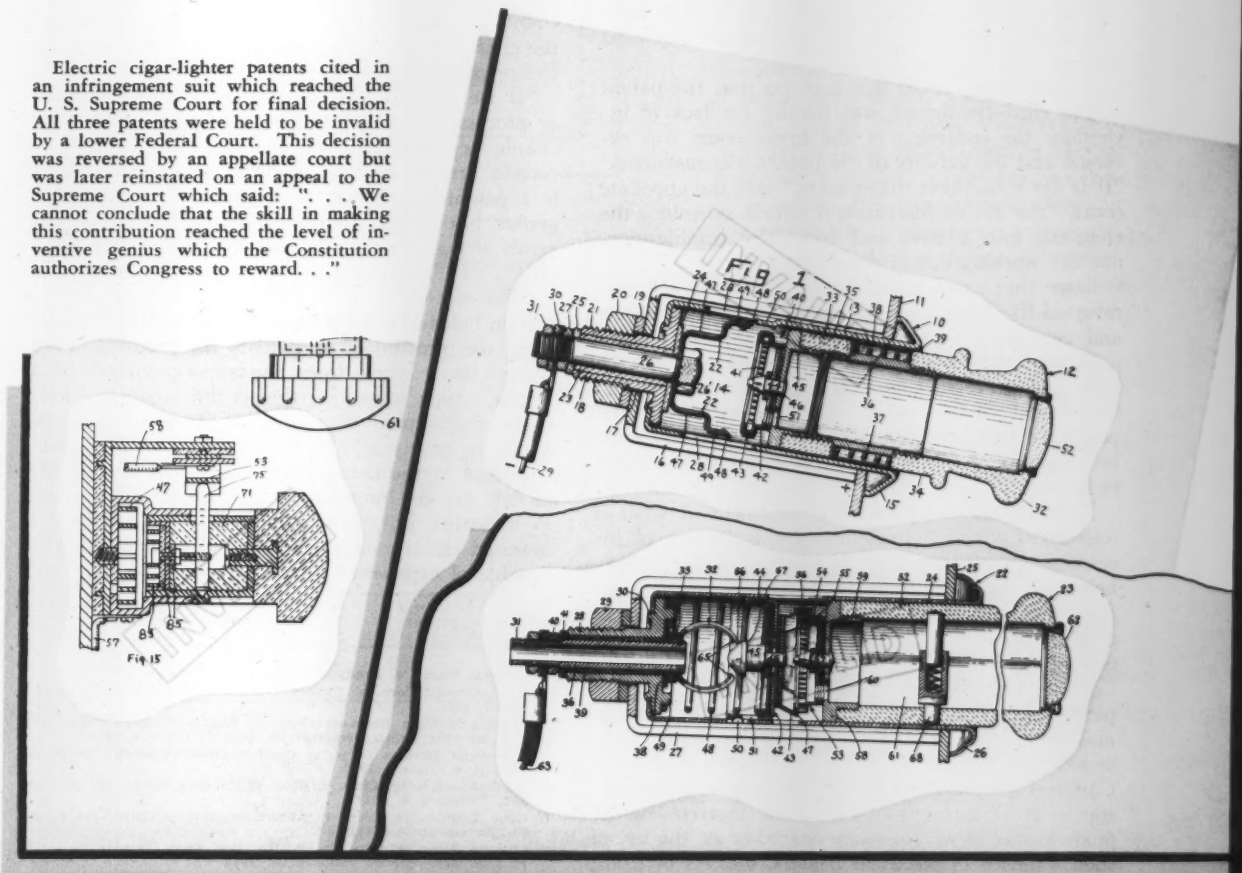
"In the long history of patent litigation in this and other courts, the search for the inventive quality in patents has often been considered and reevaluated before validating the grant of monopoly to an alleged inventor. We have given careful thought to the rationalization by which invention is perceived or found wanting, in a long series of adjudications, to the end that a patent must possess not only novelty and utility but must demonstrate an exercise of the inventive faculty.

"The adapting of a machine for a new use does not entitle one to a patent if the new use is suggested by analogous art and invention may not be perceived in the adaptation. The nonsticking virtue of 'Teflon' and its probable use in the textile industry was clearly disclosed to the art more than a year before the filing of the application for the present patent."

Then, in its conclusion denying the validity of this patent, the court added, "Teflon was not the invention or discovery of this patentee. The problem before him was to eliminate the clogging of lint in the slotted grate. The plastic that would do away with much of such clogging was at hand. Its chief characteristic was proclaimed to the world. He added it to his combination. It was as simple as that. Even though we take note of the caution against underrating simple patents, what he did was not invention."

COMPARISON of the two preceding decisions with that of another infringement action a few years before provides a better concept of the attitude of

Electric cigar-lighter patents cited in an infringement suit which reached the U. S. Supreme Court for final decision. All three patents were held to be invalid by a lower Federal Court. This decision was reversed by an appellate court but was later reinstated on an appeal to the Supreme Court which said: ". . . We cannot conclude that the skill in making this contribution reached the level of inventive genius which the Constitution authorizes Congress to reward. . ."



the courts toward this elusive feature of "invention" required by the patent law.

Suit had been brought for infringement of a patent of a cigar and cigarette lighter adapted for use in motor cars. The lower court had dismissed the action with the comment,[4] "I have little doubt that the inventor who first succeeded in applying a bimetallic circuit breaker to a portable electrical heating device made the contribution of a true inventor to society.

"But after the metallic circuit breaker had been introduced into a variety of electrical appliances such as flat-irons, coffee pots, etc., and after the electric cigar lighter had progressed through the reel stage to the wireless type of plug and socket device and the wireless type had progressed from the open face to the inverted face type, and the inverted face type had acquired semi-automatic features which held the plug in open circuit position in the absence of manual pressure, the room for future invention in this class of electric lighter was strictly limited.

"I have serious doubt whether this patentee transcended the realm of design, whether in essence he did more than produce a new design for old parts having familiar functions, arranging for the cooperation of the several parts by means thoroughly familiar to one skilled in the art of portable electrical appliances."

On the appeal from this decision that the patent of the cigarette lighter was invalid for lack of invention, the judgment of the lower court was reversed and the validity of the patent was sustained.[5] "It is the conception that counts," said the appellate court, "the act of imagination which assembles the elements into a new and fruitfuller combination, not the working out of details."

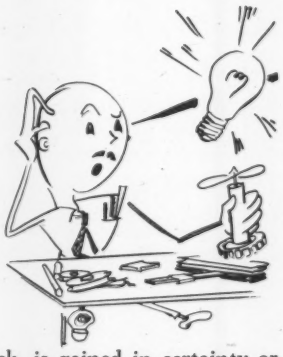
Later that same year, the U. S. Supreme Court reversed the decision of the Federal Court of Appeals and reinstated that of the lower court.[6]

"Under the statute the device must not only be 'new and useful,' it must also be an 'invention' or 'discovery.' If an improvement is to obtain the privileged position of a patent more ingenuity must be involved than the work of a mechanic skilled in the art."

To this, the court added a statement of what it considered to be the essence of this feature of invention. "The new device, however useful it may be, must reveal a flash of a creative genius, not merely the skill of the calling. If it fails it has not established its right to a private grant in the public domain.

"Tested by that principle this device was not patentable. We cannot conclude that the skill in making this contribution reached the level of inventive genius which the Constitution authorizes Congress to reward. Certainly the use of a thermostat to break a circuit in a 'wireless' cigarette lighter is analogous to, or the same character as, the use of such a device in electrical heaters, toasters or irons, whatever may be the difference in detail of design."

In conclusion the court added, "Ingenuity was required to effect the adaptation but no more than was to be expected of a mechanic skilled in the art. Strict application of the test is necessary lest in the constant demand for new appliances the heavy hand of a tribute be laid on each slight technological advance in the art."



THE doctrine that a flash of genius is an essential feature of a patentable invention was bitterly attacked two years later in a decision by the United States Court of Appeals, sustaining the patent of an apparatus for the production of feed screws and conveyors.[7]

"But what, may we ask, is gained in certainty or clarity by adopting as a test or a definition of a patentable invention or discovery the 'flash of genius' test? Is it better instead to say that the skill manifested by a worker in the art evidenced a 'flash of genius' rather than a skill beyond that of the mechanic trained in the art? Does it more truly measure the character of the advance which patentable products or processes evidence?

"If we examine the finished machine, apparatus or process, which comes from the hand of the mechanic or researcher (or genius) who works in a certain art, is it understandable to say that there is a patentable novelty if it results from a flash of genius but not a patentable invention if it is the result of long continued experimentation? We think not.

"The test of 'flash of genius' has been applied to certain fields of patentable discovery and to eliminate from the protection of patents all products, even though they come from the superior mind of a genius, which were nevertheless the product of long study and step by step advance. In short it would eliminate nearly all the advances of history, in science and in the field of mechanics. All that would be left are the products and processes which come to a genius, only occasionally, as flashes. Only a matured child prodigy, if there is any such being, is capable of experiencing such flashes."

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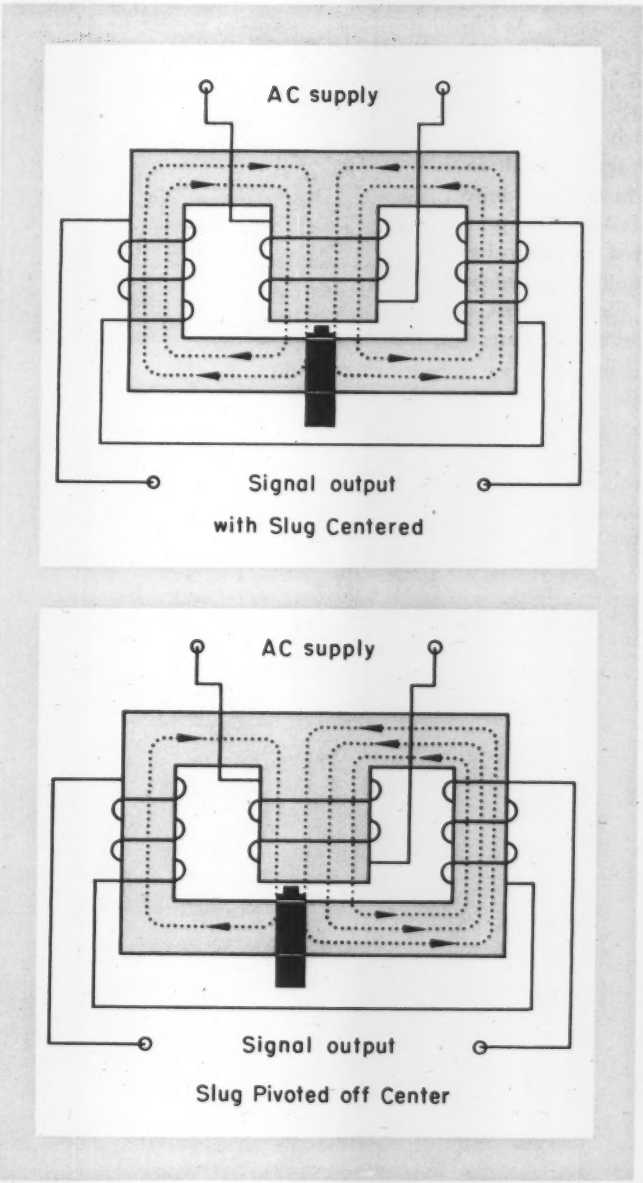
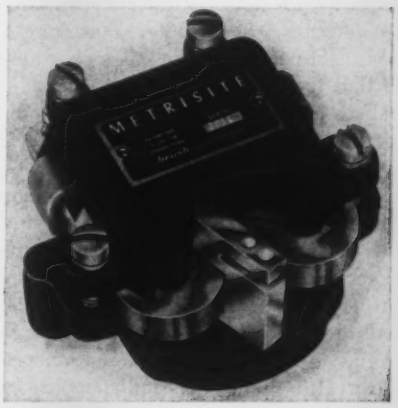
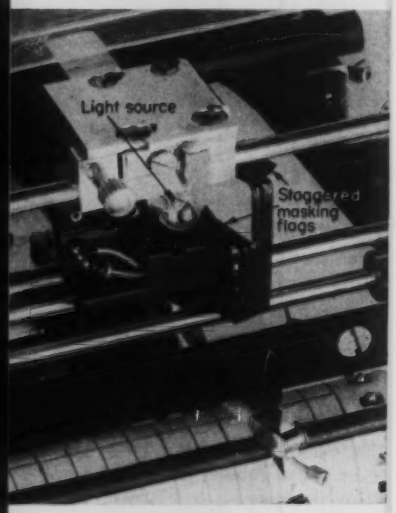
scanning the field for *ideas*

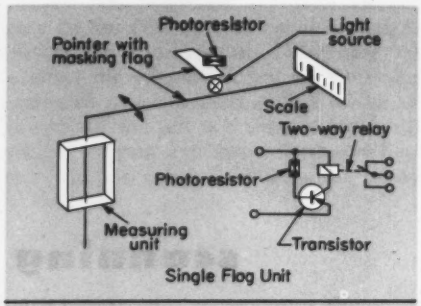


Nonconducting slug shifts magnetic field to produce electrical signal for accurate, direct measurement of linear or angular motions. A B-shaped magnetic core has an electrical coil wrapped around each of the three cross members. The center cross member contains an air gap in which a small copper slug moves. When an ac input energizes the center primary coil, a magnetic field is set up in both loops of the core, inducing a voltage in each outer coil. When the copper slug is in the dead center position, the magnetic fields are symmetrical, the induced coil voltages are equal, and there is no output voltage. When linear or angular motion is applied to the slug, it pivots off center. Resulting unbalance in the magnetic fields produces a voltage difference, generating an output current. The output signal is a measure of the motion. Magnetic-shifting principle employed in the Metrisite motion sensor developed by Brush Instrument Co., Cleveland, Ohio.

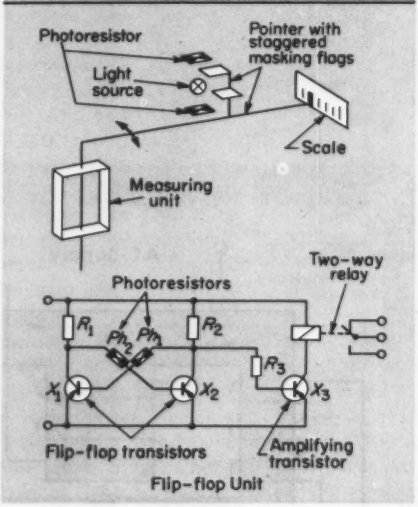


Masking flags, moving with instrument pointer, control light acting on stationary photoresistors to switch two-way relay when preset limit is reached. Design eliminates need for mechanical contacts which tend to decrease measuring accuracy. Simple version uses single flag normally covering photoresistor. As limit is reached, photoresistor is exposed to light, and transistor "opens" to switch relay and to actuate either make or break contact. Flip-flop version uses two flags which are staggered to cover, one after the other, two photoresistors mounted on opposite sides of single-light source. Photoresistors act as feedback resistors in transistor flip-flop switching relay through amplifying transistor. If X_2 is open, the circuit is stable. As Ph_1 is covered, there are no changes. As Ph_1 is uncovered and Ph_2 covered, X_2 is blocked and X_1 opened. Flip-flop tips over, and X_3 opens to switch relay. As Ph_2 is uncovered again, circuit remains stable in newly assumed position. Masking-flag principle employed in photoelectric control unit developed by Allgemeine Elektricitaets-Gesellschaft, Berlin, Germany.

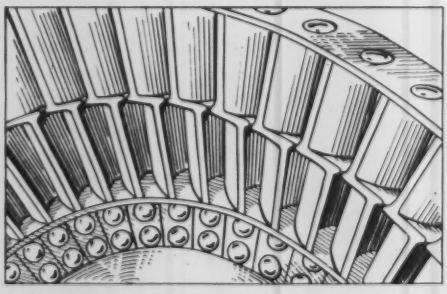




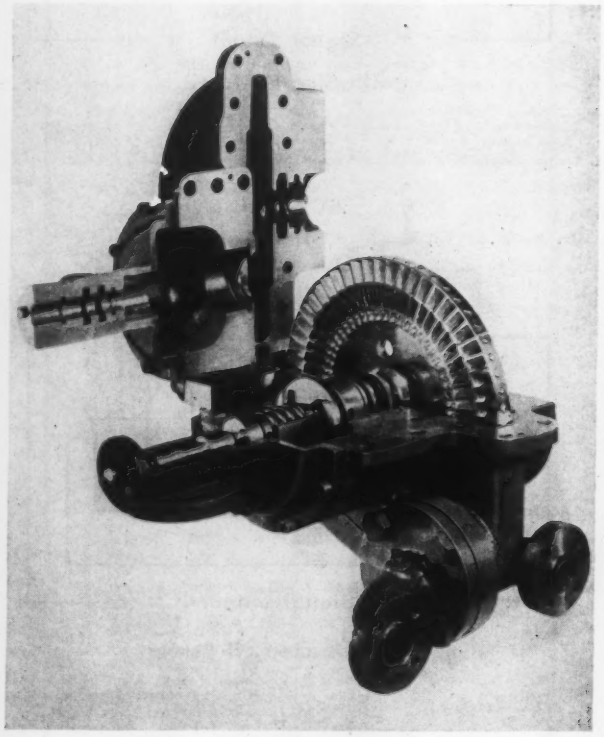
Single Flag Unit

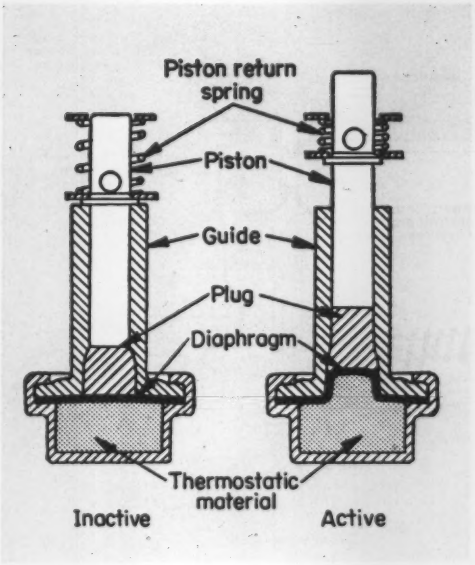


Flip-flop Unit

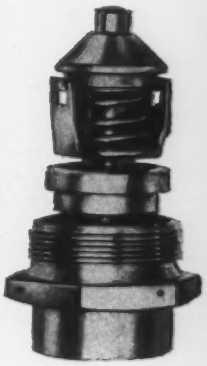


Dual-profile blade permits rotation of turbine rotor to be completely reversed without altering flow direction of working fluid. A conventional turbine blade is "twisted" so that the impingement angle of the upper half is approximately at right angles to that of the lower half. Two nozzles are used to supply the gas to the blades. If clockwise motion is desired, the gas is admitted through the nozzle for the upper half of the blade. When counterclockwise motion is required, the gas flow is simply directed through the second nozzle on to the lower half of the blade. Blade principle employed in a gas-expanding turbine developed by Dean Hill Pump Co., Indianapolis, Ind.

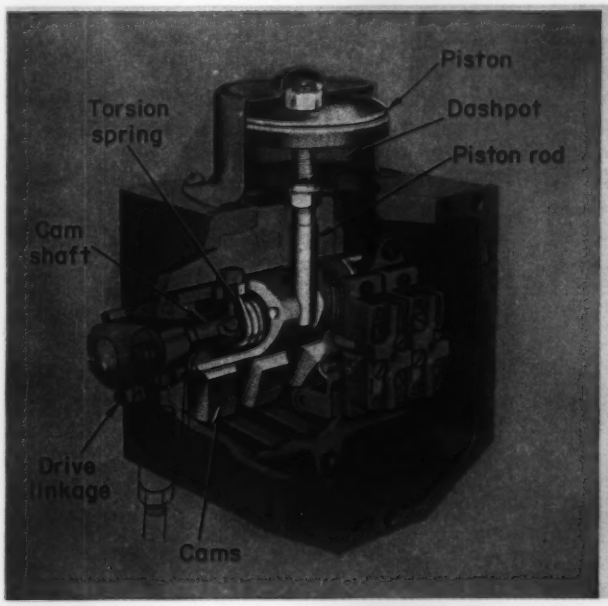


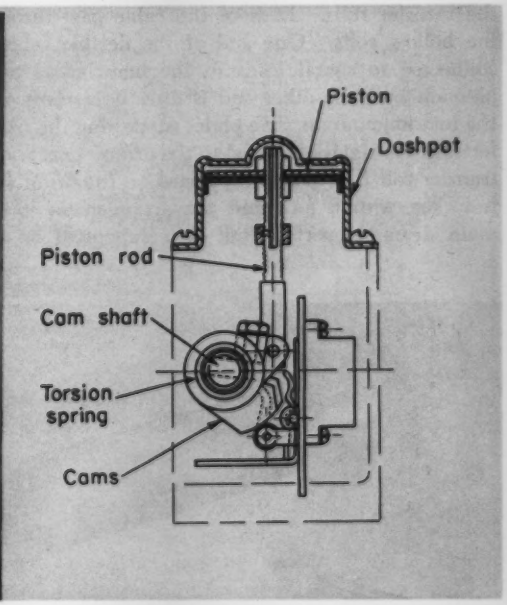


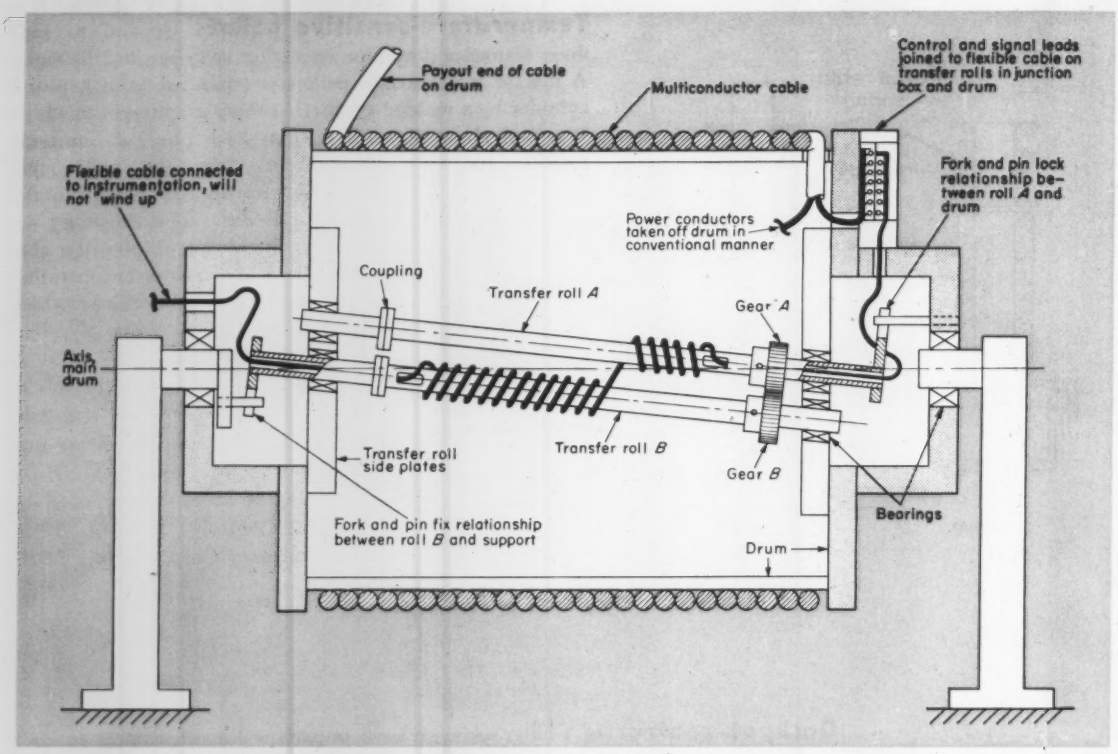
Temperature-sensitive pellets expand to produce actuating force for operating switches and linkages. A mix of hydrocarbon pellets is separated from a piston cylinder by a molded synthetic-rubber diaphragm to which is attached a piston-like over-sized plug of synthetic rubber. As the temperature rises, the pellet mix expands, forcing the plug into the small cylinder. The extruding action on the plug multiplies the plug movement and creates an operating force on the movable piston which provides actuation. A helical spring forces the piston back to its original position and returns the mix to its original shape when the temperature decreases. Temperature-sensitive pellets employed in the Vernatherm actuator developed by Detroit Controls, Div. of American-Standard Corp., Detroit, Mich.



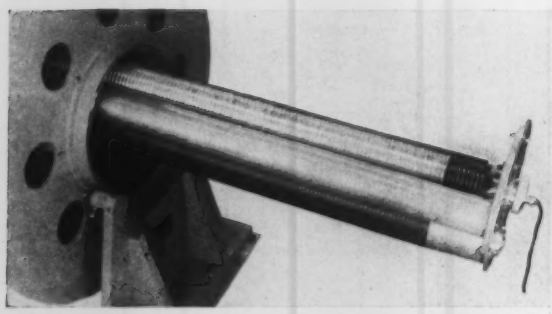
Dashpot control of torsion-spring release imparts a smooth rate of rotation to a switch-actuating cam. When the cam shaft, which is connected to the cam through a torsion spring, is rotated by a linkage arrangement, a force is applied to the torsion spring which tends to rotate the cam. A pneumatic piston rod, connected to the cam, controls the rate of spring release by equalizing the pressure in the dashpot. As the rod is moved, the air on one side of the piston is compressed. For equalization, the high-pressure air is bled into the low-pressure area through a hole in the piston rod. Hence, cam operation is smooth regardless of the type of input motion. Dashpot principle employed in a time-delay switch developed by Yale and Towne Mfg. Co., Philadelphia, Pa.

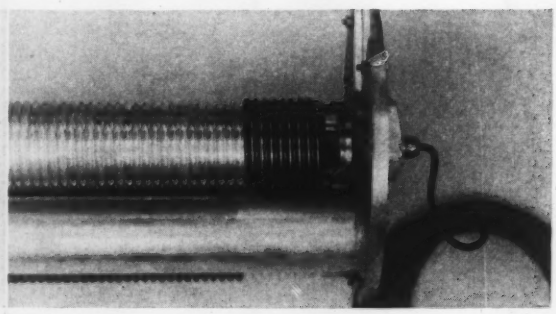


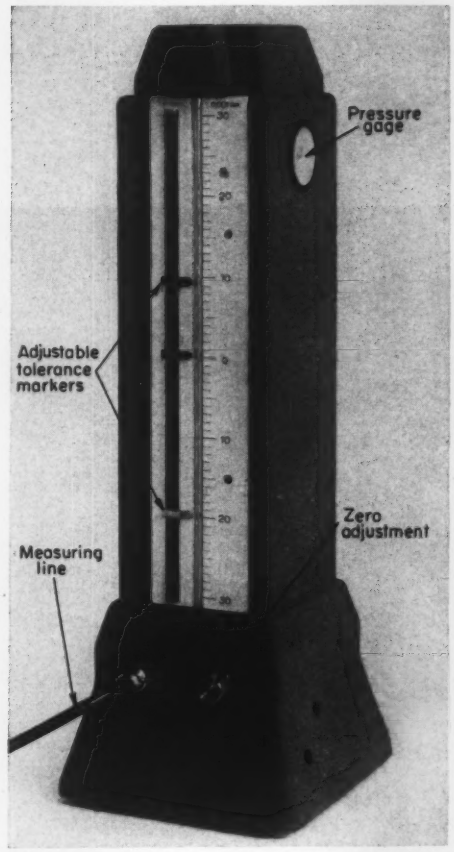


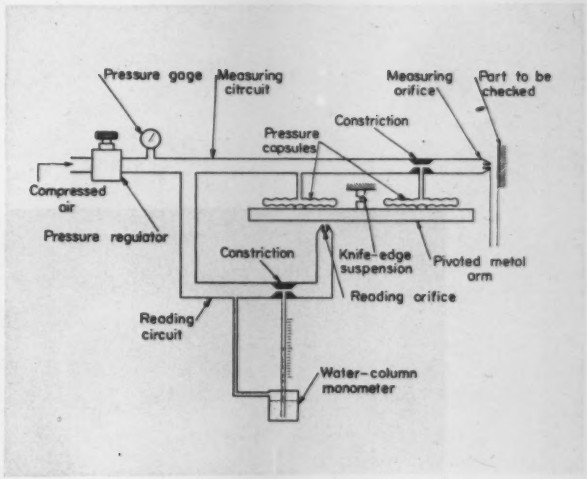

Payout end of cable on drum
Multiconductor cable
Control and signal leads joined to flexible cable on transfer rolls in junction box and drum
Flexible cable connected to instrumentation, will not wind up
Fork and pin lock relationship between roll A and drum
Power conductors taken off drum in conventional manner
Coupling
Transfer roll A
Gear A
Axis, main drum
Transfer roll side plates
Transfer roll B
Gear B
Bearings
Fork and pin fix relationship between roll B and support
Drum

Nutating rolls prevent windup or twisting of signal and control leads as multiconductor cable is payed out from storage drum. The flanged cylinder drum on which the cable is stored has two small, hollow transfer rolls mounted within. The rolls, which carry threads of opposite hand, are parallel and rotate about each other as the drum revolves. A flexible cable, containing the same number of signal conductors as the main cable, is wound on the transfer rolls. Ends of the cable pass through the hollow rolls. One end of the flexible cable is connected to signal leads in the main cable by a junction box; the other end is directly connected to the instrumentation. Side plates supporting the transfer rolls are rigidly fastened to the drum. One end of transfer roll *B*, which is supported on the drum axis, is locked with a fork and pin arrangement to the main drum supports. Roll *A* is supported on the axis of the drum by a fork and pin arrangement. Since roll *B* is fixed to the support, the drum is forced to rotate about it. Gear *B*, on the other end of roll *B*, is off center and is forced to "nutate" around transfer roll *A*. Since transfer roll *A* is fixed to the drum and turns with it, gear *A* simply rolls on gear *B*. As the drum rotates, the flexible cable transfers from one roll to the other in a direction depending on drum rotation. Thus, flexible cable emerging from roll *A* maintains a fixed relationship to the main cable on the drum and can be connected to the junction box on the drum. Flexible cable emerging from roll *B*, maintains a fixed relationship to the support, and consequently can be directly fastened to anything off the drum. Reported by Herbert A. Krivka, nutating roll principle is employed in a cable payout winch developed by Vitro Laboratories, Silver Spring, Md.

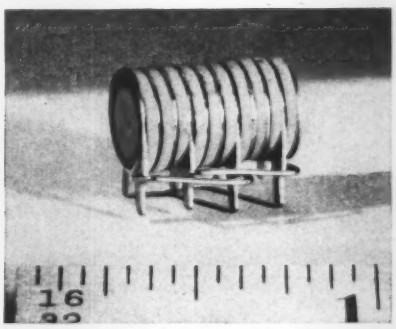


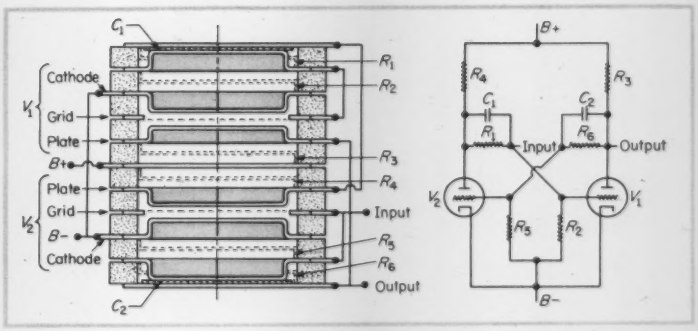




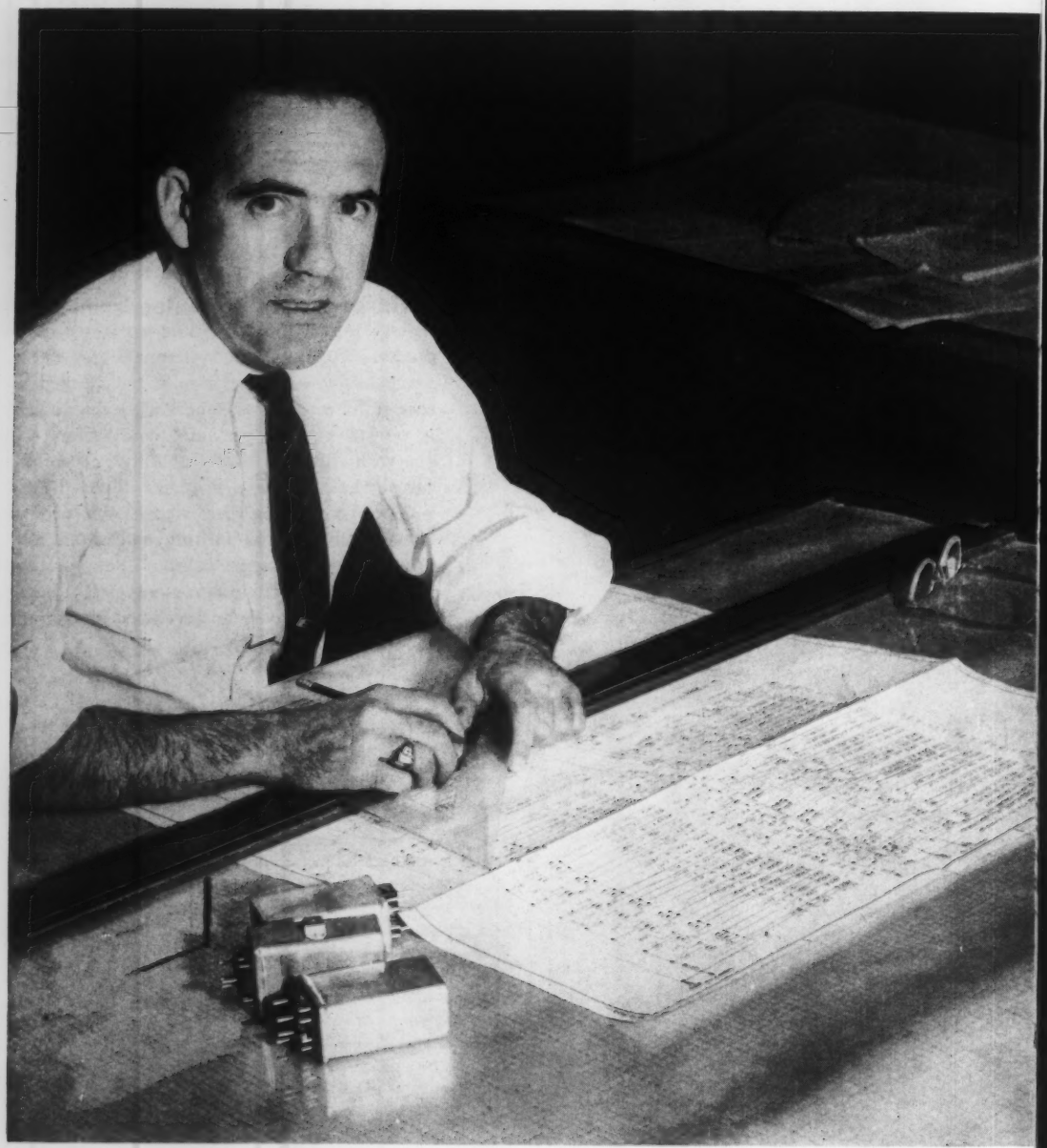


Twin pressure capsules transform pressure difference into a linear reading on water manometer. In a pneumatic-comparator system, the gap between the measuring orifice and the part to be checked sets up a pressure differential in the measuring circuit. This difference is sensed by two pressure capsules and causes them to act with different forces at different points on a pivoted metal arm. As the arm pivots, the gap between the reading orifice and the arm increases or decreases creating a pressure differential in the reading circuit. This difference acts on a water-column manometer which is calibrated for direct measurements. Readout principle employed in a comparator developed by Compac, Chatelaine-Geneva, Switzerland.





Self-heating electronic circuits permit the use of high-frequency vacuum tubes in miniaturized modules. The small ceramic modules, each of which contains a complete electronic circuit which includes vacuum tubes, resistors, and capacitors, contain no heaters. To start a reaction, a small amount of heat is applied to the entire circuit. Once the reaction is started, the active and passive components generate enough heat to continue the reaction. This heat is utilized by enclosing the circuitry in an insulated box to prevent heat loss. The modules can be built into stacks varying in size with the complexity of the required circuit. Self-heating circuit principle employed in Timms thermionic integrated micromodules developed by Receiving Tube Dept., General Electric Co., Owensboro, Ky.



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Static control is somewhat of a newcomer as an electrical control system for industrial machines and continuous processes. But its design popularity is growing fast for one simple reason: Extreme reliability of operation over long periods of time in almost any environment.

Static control systems are built from *AND*, *OR*, *NOT*, *MEMORY*, and *time DELAY* logic functions. These special little *on-off* circuit elements are easy to use once their characteristics and capabilities are known. Here is a simplified, cookbook approach using logic functions for . . .

Designing Static Control Circuits

MAJOR design advantage of a static electrical control is the absence of moving parts and contacts in the circuit elements. Known as logic functions, these circuit elements are composed primarily of saturable reactors, insulated wire, and semiconductors. The components in each element are wired together, covered with a foam-rubber like material, and sealed in a small metal can. As a result, an electrical control system built of these static elements is highly reliable. In addition, trouble-free operation can be expected in environments which are normally dusty, greasy, abrasive, damp, sticky, or even mildly corrosive.

Logic function elements offer great design versatility since they respond to multiple signal inputs. Also, signal response time is about three times faster in a static control system than in a comparable relay system.

One drawback of static control, to date, is slightly

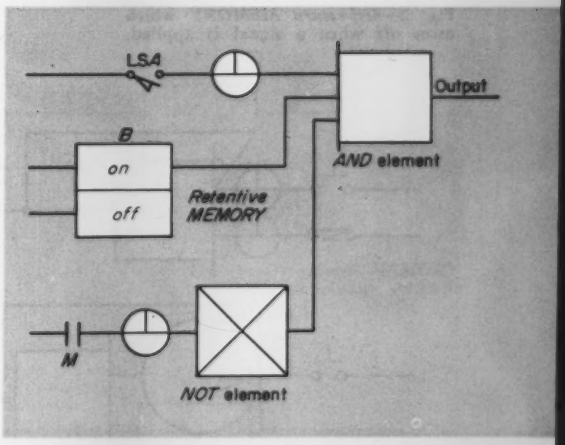


Fig. 1—Typical static control circuit designed with logic functions. Output from the *AND* element occurs only when three inputs are applied at the same time.

Designing Static Control Circuits

higher initial cost. Then, too, many designers lack familiarity with logic elements, and how to attack a static-control circuit design problem.

Functions and characteristics of logic elements are given in Table 1 and their relay-schematic equivalencies in Table 2. These tables merit careful study.

Circuit Design

Successful design of a static-control circuit depends on thinking in logic-function terms. For example, if an output is desired when: 1. Limit switch *A* is closed. 2. *Retentive MEMORY* element *B* has an output. 3. A normally open contact of motor starter *M* is not energized, the designer should visualize the diagram in Fig. 1.

When circuit development is begun, a logic diagram should be drawn for each sequence separately, as done in Examples 1 and 2. Involved sequences may have to be broken apart for clarity, although this is rarely necessary. When a signal is needed

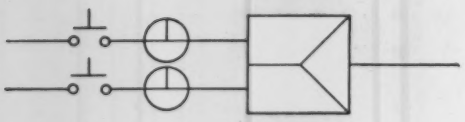


Fig. 2—*Off-return MEMORY* which turns off when a signal is applied.

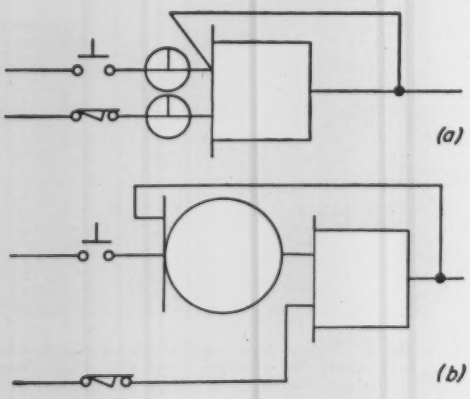


Fig. 3—Two equivalent circuits which maintain an output even though one input is momentary.

Table 1—Static-Control Logic Symbols and Functions

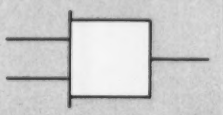
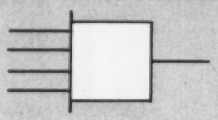
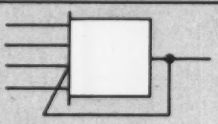
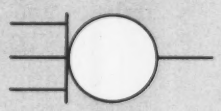
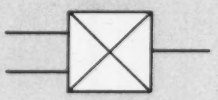
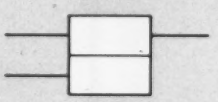
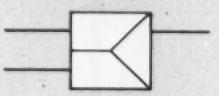
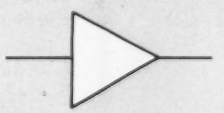
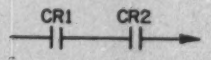
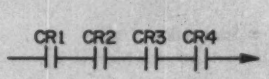
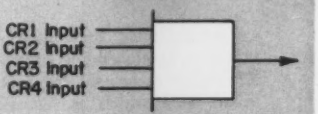
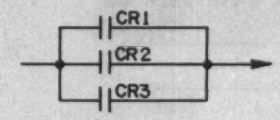
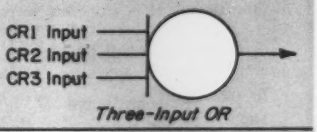
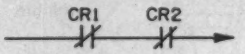
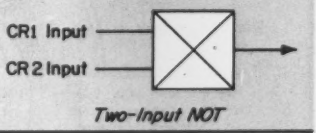
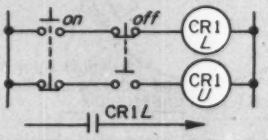
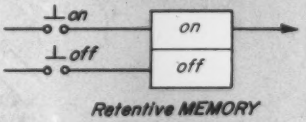
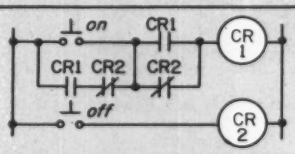
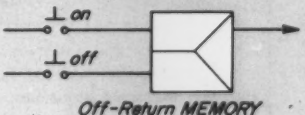
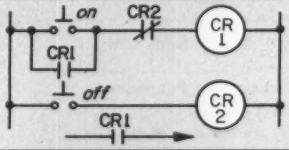
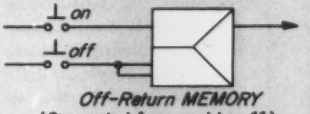
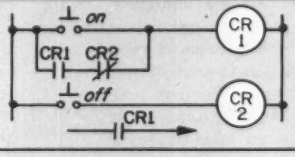
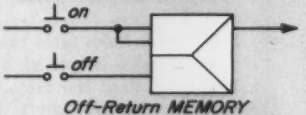
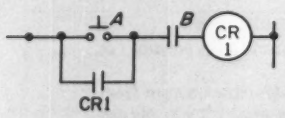
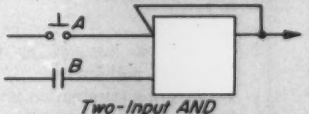
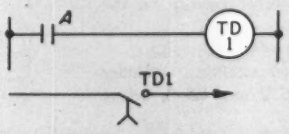
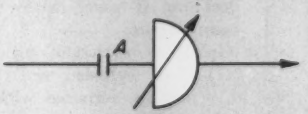
Function	Symbol
Two-Input AND: All inputs must be present to establish and maintain an output.	
Four-Input AND: All inputs must be present to establish and maintain an output.	
Sealed Four-Input AND: All inputs must be present to establish an output, three inputs to maintain an output.	
Three-Input OR: Any input or any combination of inputs must be present to establish and maintain an output.	
Two-Input NOT: Produces full output with no inputs. Either or both inputs will stop the output. This element is actually an *OR-NOT* function often called *NOR*.	
Retentive MEMORY: A momentary input will produce a sustained output. In event of power interruption, unit retains its state when power is restored.	
Off-Return MEMORY: A momentary input will produce a sustained output. In event of power interruption, unit always returns to the off condition when power is restored.	
Time DELAY: An input produces an output after a pre-set period of time. The output will continue until the input is removed.	
Output Amplifier: Produces a power output when a signal input is present.	
DC Original Input: A device which converts 120 v dc to a proper signal to drive a logic element.	
AC Original Input: A device which converts 120 v ac to a proper signal to drive a logic element.	

Table 2—Equivalent Relay and Logic Elements

Relay Schematic	Equivalent Logic Element
	
	
	
	
	
	
	
	
	
	

which will be developed in another sequence, a signal input labeled with the proposed source should be shown.

Before any type of electrical control system can be designed, the machine cycling requirements must be known in detail. This design fundamental is true for static control, too. Therefore, the complete operating cycle of the machine should be written down, sequence by sequence, Examples 1 and 2. The following information should be listed with each sequence of operation:

1. Overall function to be accomplished.
2. Initial operating conditions.
3. Sequence-initiating information source and whether the characteristic is momentary or maintained.
4. Sequence-terminating information source and whether the characteristic is momentary or maintained.
5. Restrictions to be imposed on the sequence.

The next design consideration in each sequence is

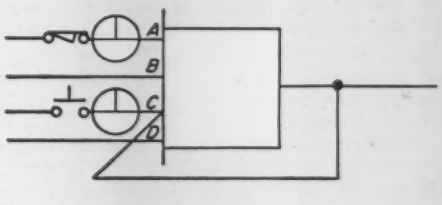


Fig. 4—Sealed *four-input AND* which allows one input to be momentary. Loss of any one of inputs *A*, *B*, or *D* will stop the output.

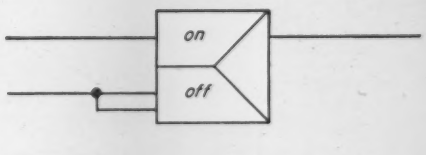


Fig. 5—*Off-return MEMORY* connected to obtain override *on*.

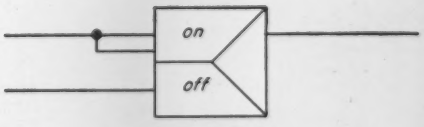


Fig. 6—*Off-return MEMORY* connected to obtain override *off*.

Designing Static Control Circuits

Example 1: Static Control for an Alarm

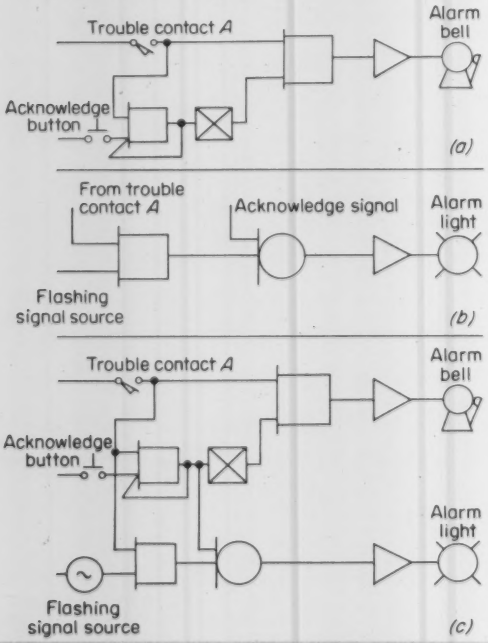
A control circuit must be designed for an alarm which operates on the following cycle. When trouble closes contact *A*, a bell rings and a light on the machine control panel flashes. The machine operator is to acknowledge the difficulty by pressing a button which will silence the bell, and change the light from a flashing to a steady condition. When the trouble contact *A* opens, the circuit resets under all conditions.

Before the circuit can be designed, the following sequences of operation must be set up:

1. When trouble occurs, bell and flashing light are energized. Trouble contact *A* and acknowledge button contact are normally open.
2. Trouble contact *A* initiates the alarm by means of a maintained signal.
3. Alarm bell stops ringing when either acknowledge button is pressed or trouble contact *A* opens.
4. Flashing light changes to steady light when acknowledge button is pressed and/or is turned off by opening of trouble contact *A*.

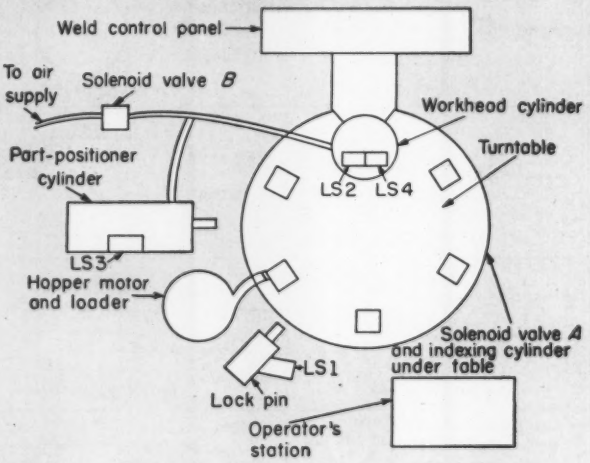
In this sequence, the alarm bell is energized when trouble contact *A* is closed *AND* the operator has *NOT* pressed the acknowledge button, Fig. *a*.

In addition a flashing light must be energized when the trouble contact is closed. The light will go off when the trouble contact *A* is opened *OR* it will go on steady when the acknowledge button is pressed, Fig. *b*. The circuits for the two alarm signals can be combined, as in Fig. c.



Example 2: Static Control for an Auto-

The following steps show how a static-control circuit was developed for an automatic welding machine. The work surface of the machine is a horizontal circular table which is indexed in finite steps. After each index of the table, a workhead cylinder extends and an operation is performed on a part which was positioned at a previous work station.



Specifically, the machine function was broken down into the following sequences.

Automatic Cycle

Sequence 1: Start hopper motor which feeds raw parts to positioning cylinder.

a. With the circuit, initially de-energized automatic cycle is started by the motor start button.
b. Automatic cycle is terminated by motor stop button.
c. Design restrictions include overload and undervoltage protection.

Sequence 2: Index table by energizing solenoid valve *A*. As the table is indexed, a lock pin is mechanically cammed out until the table arrives at the next position where the lock pin is mechanicaly cammed in. Solenoid valve *A* is de-energized when table arrives at next position.

a. Solenoid valve *A* is not energized initially.
b. Sequence is initiated by momentarily pressing of cycle-start pushbutton.
c. Terminating information is a maintained output from limit switch LS 1, which occurs after LS 1 is opened when the lock pin is cammed out and reclosed. The lock pin is seated when the table indexes to the next station.
d. Operating restrictions include:
   (1) Head cylinder and part-positioning cylinder must be retracted with LS 2 and LS 3, before

table can be indexed.

(2) Emergency stop button must be actuated to stop index motion at any time.

Sequence 3: Extend part-positioner cylinder and head cylinder by energizing solenoid valve *B*.

a. Solenoid valve *B* is initially de-energized.
b. Sequence is initiated when table completes index to station. Information is obtained from maintained output of LS 1 closure when lock pin is seated.
c. Sequence 3 overlaps sequence 4 and is terminated by a momentary closing of a contact in the welding control.
d. Restrictions include:

(1) Lock pin must be in before part-positioning cylinder and head cylinder can extend.

(2) Emergency stop button can be actuated to retract part-positioning cylinder and welding head at any time.

Sequence 4: Begin welding cycle.

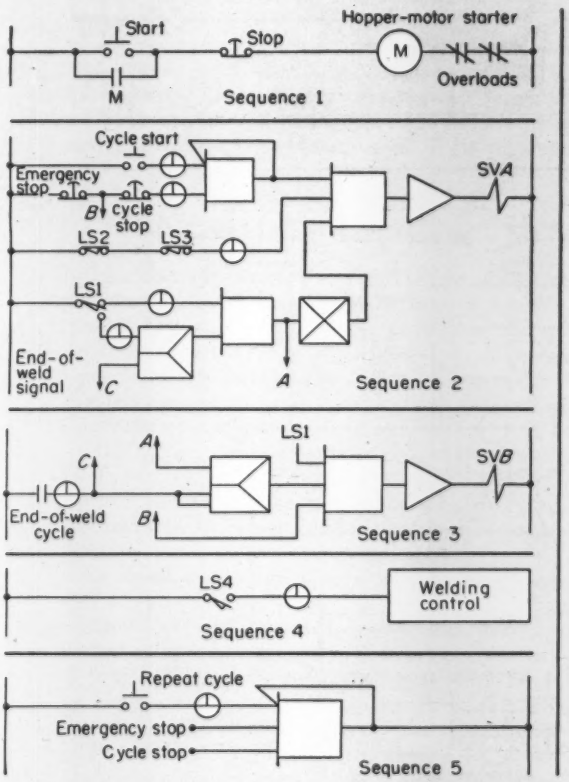
a. Welding circuit is initially de-energized.
b. Cycle is initiated by closing LS 4, which is a limit switch actuated when the head extends and engages the part.
c. Cycle is terminated by a momentary closing of a contact in the control.
d. Restrictions, if any, are in the control which is furnished as a unit.

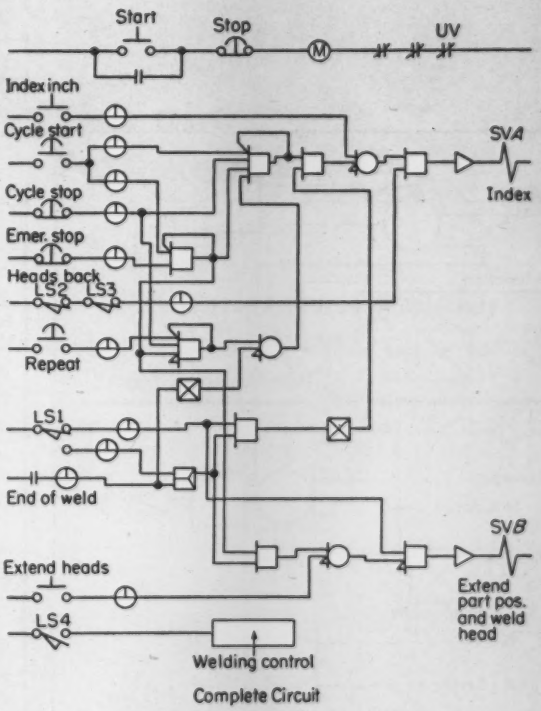
Sequence 5: End cycle, unless repeat pushbutton is pressed momentarily, in which case the complete cycle repeats continuously until cycle stop button or emergency stop button is pressed.

Manual Operation

Sequence 1: Operator must be able to inch table as long as part positioning and welding head cylinders are both retracted. LS 2 and LS 3 held closed.

Sequence 2: Operator must be able to extend and retract head and positioning cylinders by hand as long as lock pin is in.





whether input signals are momentary or maintained.

Maintained Signal Inputs: So far as *AND* and *OR* functions are concerned, a maintained or continuous signal input is required to produce a maintained or continuous signal output. In the case of the *NOT* function a maintained input produces no output.

Momentary Signal Inputs: In any type of electrical control circuit, signals are often only momentary. When dealing with momentary inputs where a maintained output is desired, *MEMORY* elements are usually required. There are several types of *MEMORIES* available, each having a distinctly different use.

If it is mandatory that the control must remember its state through a system power interruption, a *retentive MEMORY* should be applied in the circuit design.

If a device must return to the *off* state when power is restored after an interruption, an *off-return MEMORY* or the seal-in ability of the *AND* function can be used to achieve memory. The choice

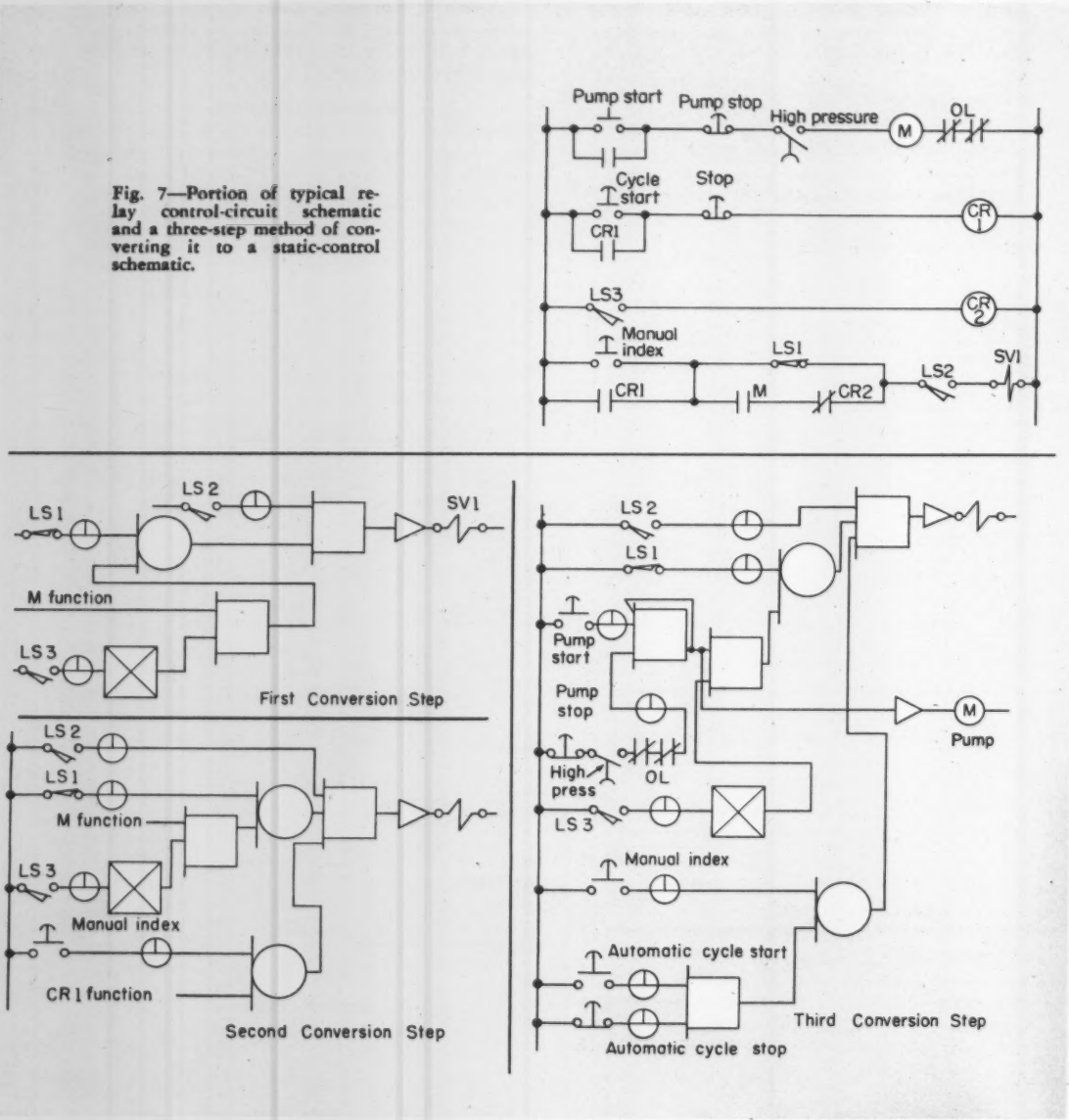


Fig. 7—Portion of typical relay control-circuit schematic and a three-step method of converting it to a static-control schematic.

between the latter two devices depends on the input conditions.

If the application of a signal is supposed to turn *off* the memory output, an *off-return MEMORY*, Fig. 2, can be applied. If the loss of a signal is to turn off the memory, the sealed input of a *two-input AND*, Fig. 3 *a*, can be used. Its functionally equivalent circuit appears in Fig. 3 *b*.

If a loss of any one or more of several inputs is desired to stop the output, a sealed *four-input AND*, Fig. 4, can be employed. In this element, loss of inputs *A*, *B*, or *D* will stop the output.

If an *off* input and an *on* input to a *MEMORY* must both be present, the *retentive MEMORY* will always have its output concur with the first signal applied. If both signals are applied simultaneously, the *retentive MEMORY* will not change its state. With the normal connections, the *off-return MEMORY* acts like the *retentive MEMORY* with respect to having both the inputs energized, except that a third input winding is available which has several uses. Connections can be made so this device can override an unwanted signal. This is accomplished by connecting two of the three windings in series to obtain an override *on*, Fig. 5, or an override *off*, Fig. 6.

Where the override feature is not required but the *off-return* MEMORY has a *two-input* OR function driving one of the inputs, the override winding can replace the OR element. This arrangement will also provide an override function if all the inputs are energized.

Combining Sequences

The next step in static-control circuit design is to combine the individual sequences into an integrated control system. Circuit-design alterations are often necessary to make the sequences compatible with each other to achieve continuity of the operating cycle. Examples 1 and 2 show how the sequence diagrams are integrated.

The finished circuit diagram should be thoroughly checked against its functional specifications. Static-control simulators are helpful in checking out a finished circuit design, since the machine can be "run" as soon as the circuit is designed.

In checking through a new control-circuit design, the designer should first find out if the control accomplishes its intended sequencing during all modes of normal operation. If it does, operation of control and machine should be investigated in event of unexpected power interruption. After this, check the effect of a part jamming in the machine, or a malfunction of a pilot device should be checked. Difficulties encountered in these areas can usually be changed by a slight alteration of the design or the use of additional interlocking.

Once the basic logic schematic has been roughed out, the only remaining design activity is the preparation of a combination schematic and wiring diagram.

Converting Relay Circuits

It is quite possible to convert a relay control circuit to a static control circuit using the function equivalencies in Table 2. Although a direct substitution of static-control elements can be made from a relay schematic, this design approach may be wasteful. When circuits are designed for relays, additional relay contacts are often used for isolation or load splitting. This procedure usually is not necessary with static-control elements.

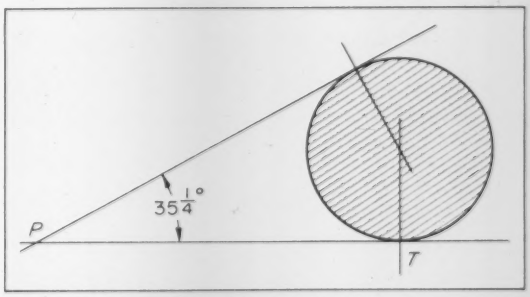
Generally speaking, however, a static-control circuit designed from a circuit using relays will give a reasonable indication of the circuit configuration, size, and complexity. When functional and operational specifications are available, this is usually the only quick way to design a static-control circuit. In making the conversion, usually the best procedure is to work backward from the driven load to the original information.

Fig. 7 shows how a relay control circuit was converted to a static-control circuit in three steps.

Tips and Techniques

Circle Circumferences Graphically

The circumference of a circle can be laid out in the following manner. Draw a line tangent to the cricle at *T*. Draw a second line tangent to the circle at an angle of 35¼ deg to the first. The intersection *P* measures out a length *PT* which is equal to one-half the circumference.—F. Murray, *Chicago, Ill.*



torsion bars

Fig. 1—Conventional torsion-bar arrangement.

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SIMPLE in form and principle, torsion-bar springs are highly efficient energy-storage devices. A torsion bar, Fig. 1, can store four times as much energy as an equally stressed leaf spring of the same weight. Torsion bars have similar advantages over helical coil springs.

Although well-known in automotive applications, torsion-bar springs have not been widely applied in other machines. Their efficiency recommends them and, with the methods presented here, design is simple and straightforward.

Design Practices: Torsion bars are generally made of silico-manganese steels, such as SAE 9260. Maximum operating torsional shear strength ranges from 100,000 to 150,000 psi depending on the method of processing.

When bars are hardened, surface decarburization should be avoided in heat treatment. Design should allow for heat-treat distortion so that straightening after tempering is minimized.

Fatigue resistance of torsion bars is increased by shot peening and presetting. Presetting increases the strength of the bar in the direction of preset so that an allowable stress greater than the yield stress may be used for design. However, the strength of the bar when twisted opposite to preset is decreased. Thus, preset should not be specified for bars which are to be used interchangeably with clockwise and counterclockwise windup.

Diameter of the torsion-bar end is generally 25 to 35 per cent larger than the working section of the bar. Vee serrations with generous root radii, involute splines, or some other locking form such as the hexagon are used at the ends to transmit torque.

Splines permit the smallest end diameters. Allowable pressure on the flanks is 150,000 psi, based on

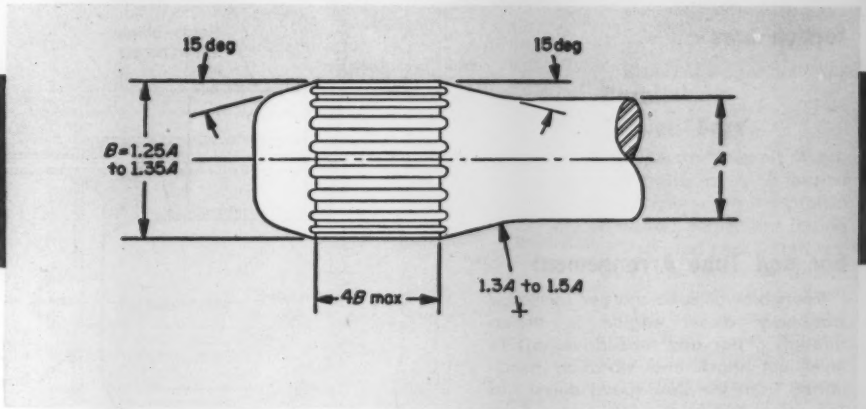


Fig. 2—Recommended practice for design of torsion-bar ends.

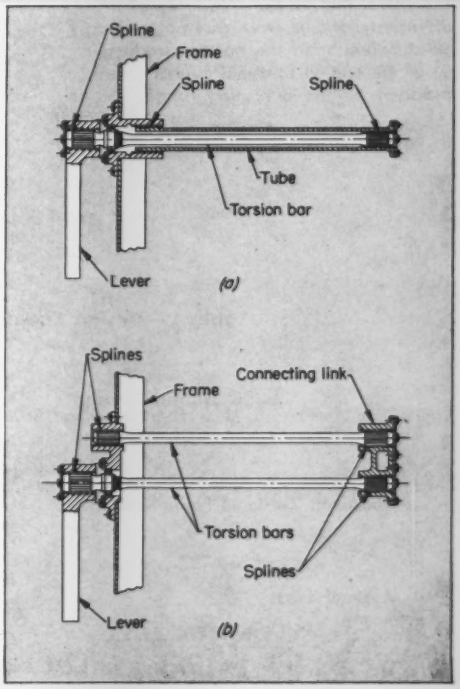


Fig. 3 — "Doubling-back" arrangements for torsion-bar springs: *a*, bar and tube method; *b*, parallel method.

all splines in contact. Spline length should be no more than four times the spline diameter. Tolerances and allowances should be such that length of outer splines always overlaps inner splines.

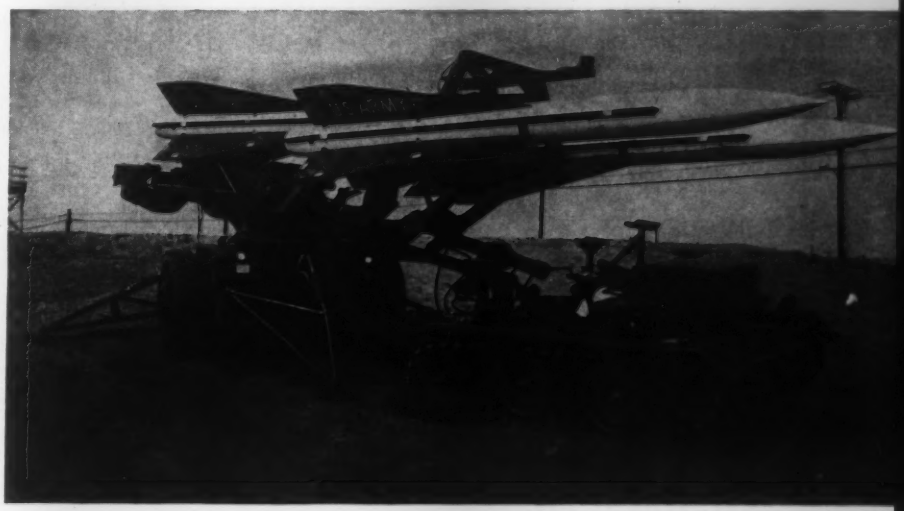
A gradual transition from bar diameter to end diameter minimizes stress concentration. Recommended practice for design of bar ends is shown in Fig. 2.

Design equations for solid and hollow round-section torsion bars are summarized in Table 1.

Application Alternatives: "Doubling back" arrangements, Fig. 3, can be used when there is insufficient space for one long torsion bar. With the

Single Torsion Bar

Bogies of the track laying loader (foreground) for U. S. Army Hawk Missiles are suspended on trailing arms with torsion-bar springs which extend the full width of the loader chassis. Deflection of the center bogie can be seen. The bogies on one side of the chassis are offset from those on the other side to allow clearance between opposing torsion bars. Both the launcher and the loader were designed by Northrop Corp. under an Ordnance subcontract to Raytheon Mfg. Corp.



Bar and Tube Arrangement

Roots-blower supercharger for large stationary diesel engine is driven through a bar and tube driveshaft to level out shock and vibration transmitted from the slow-speed diesel. In this drive, the natural frequency of the driveshaft and blower assembly must be different than the natural frequency of the engine to avoid critical-speed problems in the operating range.

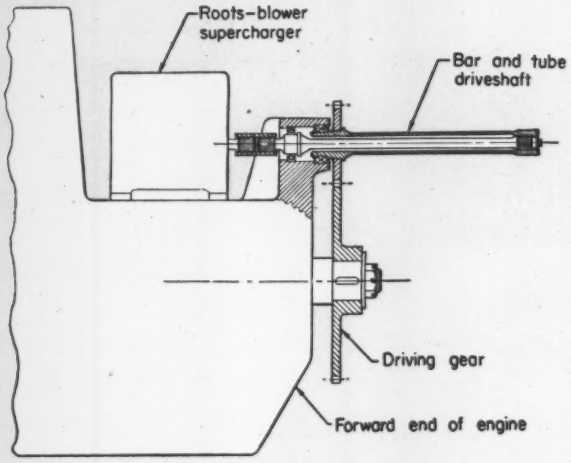


Table 1—Design Equations for Round-Section Torsion-Bar Springs

Solid Round Section

Maximum Torsional Shear Stress

$$S = \frac{16T}{\pi D^3} \quad (1)$$

Angle of Twist

$$\theta = \frac{584\,TL}{GD^4} \quad (2)$$

$$\theta = \frac{114.6\,SL}{GD} \quad (3)$$

Spring rate

$$R = \frac{GD^4}{584\,L} \quad (4)$$

Energy Storage Capacity

$$E = \frac{S^2}{4G} \quad (5)$$

Hollow Round Section

Maximum Torsional Shear Stress

$$S = \frac{16TD}{\pi(D^4 - d^4)} \quad (6)$$

Angle of Twist

$$\theta = \frac{584\,TL}{G(D^4 - d^4)} \quad (7)$$

$$\theta = \frac{114.6\,SL}{GD} \quad (8)$$

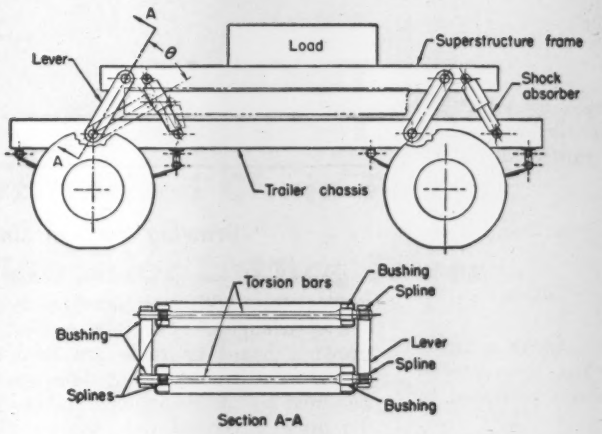
Spring Rate

$$R = \frac{G(D^4 - d^4)}{584\,L} \quad (9)$$

Energy Storage Capacity

$$E = \frac{S^2(D^2 + d^2)}{4GD^2} \quad (10)$$

D = Outside diameter, in.
d = Inside diameter, in.
E = Energy storage capacity, in.-lb per cubic in.
G = Shear modulus of rigidity, psi
L = Effective length of torsion bar, in. = Length of straight section plus ½ length of each tapered section
R = Spring rate, lb-in. per deg
S = Maximum torsional shear stress, psi
T = Applied torque, lb-in.
θ = Angle of twist, deg



Parallel Torsion Bars

Superstructure on standard trailer body is floated on torsion bars to protect delicate equipment being transported over rough terrain. As the trailer passes over an obstruction, both torsion bars in each of the suspensions twist through an angle, θ, allowing the superstructure frame to deflect as shown by the phantom lines. Section view shows the parallel-bar arrangement used in each suspension.

bar and tube method, Fig. 3*a*, both elements are subjected to the same torque and both twist to give the desired deflection. Total angular deflection is the sum of the deflections of each element.

In the parallel method, Fig. 3*b*, the bars are coupled at one end by a link which transfers torque and angular deflection from one bar to the other with slight bending in each bar. Both bars have the same angular deflection, and total torque is the sum of the torques in each bar.

When operating space is limited, a long lever arm, a large bar diameter, a high working stress, or a "doubling-back" arrangement may be necessary to keep bar length confined. The following example illustrates some of the design possibilities.

Design Example: A solid steel torsion bar ($G = 11.5 \times 10^6$ psi) is loaded through a lever 10 in. long. Normal load at the end of the lever is 1000 lb. If maximum deflection at the end of the lever is 7 in. and maximum torsional shear strength of the bar material is 100,000 psi, find the bar dimensions.

From Equation 1, Table 1,

$$D^3 = \frac{16\,W\,a}{\pi\,S}$$

where W = normal load, lb; and a = effective lever length, in. Solving for D,

$$D = \left[\frac{16(1000)\,(10)}{3.14(100{,}000)}\right]^{1/3} = 0.798 \text{ in.}$$

The angle of twist corresponding to maximum lever deflection is, Fig. 4,

$$\theta = 2\sin^{-1}\left(\frac{c}{2a}\right) = 2\sin^{-1}\left(\frac{7}{20}\right) = 41 \text{ deg}$$

From Equation 3, Table 1,

$$L = \frac{11.5(10^6)\,(0.798)\,(41)}{114.6(100{,}000)} = 32.8 \text{ in.}$$

Assume that lever length a is increased to 12 in. Then,

$$D = 0.798\left(\frac{12}{10}\right)^{1/3} = 0.848 \text{ in.}$$

$$\theta = 2\sin^{-1}\left(\frac{7}{24}\right) = 33.9 \text{ deg}$$

$$L = 32.8\,\frac{0.848(33.9)}{0.798(41)} = 28.8 \text{ in.}$$

As can be seen, increasing lever length increases bar diameter but also decreases angle of twist and bar length required to handle the same deflection. In this instance, increasing the lever length 2 in.

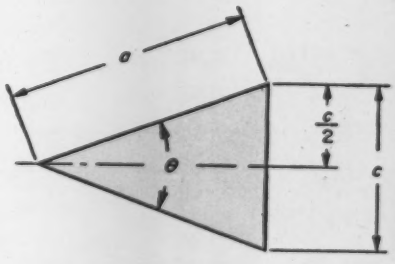


Fig. 4—Relationship of angle of twist θ to lever deflection c in torsion bar spring with lever length a.

has reduced the required bar length by 4 in.

Assume now that maximum torsional shear strength of the bar material is raised to 130,000 psi. Then,

$$D = \left[\frac{16(1000)(12)}{3.14(130{,}000)} \right]^{1/3} = 0.777 \text{ in.}$$

$$L = \frac{11.5(10^6)(0.777)(33.9)}{114.6(130{,}000)} = 20.3 \text{ in.}$$

This result shows the advantage in using a higher strength bar material. Not only has bar diameter been reduced but bar length has been shortened by over 8 in.

Consider now the effect of a "doubling back" arrangement. For the parallel method, Fig. 3*b*, the sum of the D^3 values for each of the bars must equal that of the single bar. Also, the length of the group of bars, as a percentage of the length required for one bar, is

$$l = \frac{100}{N^{1/3}}$$

where l = length of the group of bars, per cent; and N = number of bars in the group. For the example considered here, using the arrangement shown in Fig. 3*b*,

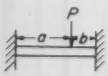
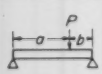
$$l = \frac{100}{2^{1/3}} = 79.3 \text{ per cent}$$

Length of the two bar assembly is 20.3 (0.793) = 16.1 in., a further reduction in length of over 4 in.

Thus, the original computed design length of the torsion bar has been reduced over 50 per cent by increasing the lever length and working stress level and by doubling back.

Round Section Beams

In "Round-Section Beams," August 20 issue, Pages 179-181, cases 4 and 7 of Table 1 should appear as follows:

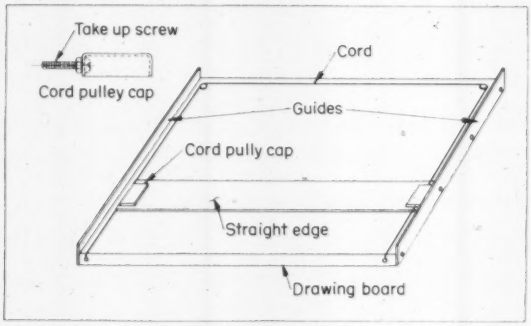
Case 4		$P\dfrac{a^3 + 3a^2b}{(a+b)^3}$	$\dfrac{2b^2}{a+3b}$ $(a \geqq b)$
Case 7		$P\dfrac{a}{a+b}$	b $(a \geqq b)$

Also, the reference notation on the line preceding Equation 4 should be for Reference 2 instead of Reference 1.

Tips and Techniques

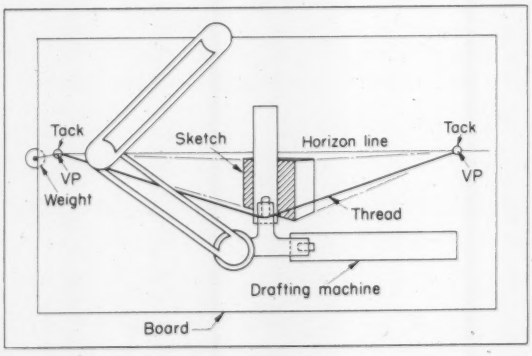
Drawing Vertical Lines

Considerable time can be saved when drawing vertical lines with a straightedge by eliminating the use of triangles. Two side guides attached to the drawing board or table are used to prevent the straightedge from moving sideways. A small screw mounted on the straightedge takes up the side play. To draw a vertical line, the pencil is in position against the straightedge as the straightedge is drawn downward toward the front of the board.—C. A. BULMER, *engineering supervisor, Harper Electric Furnace Corp., Buffalo, N. Y.*



Perspective Drawings

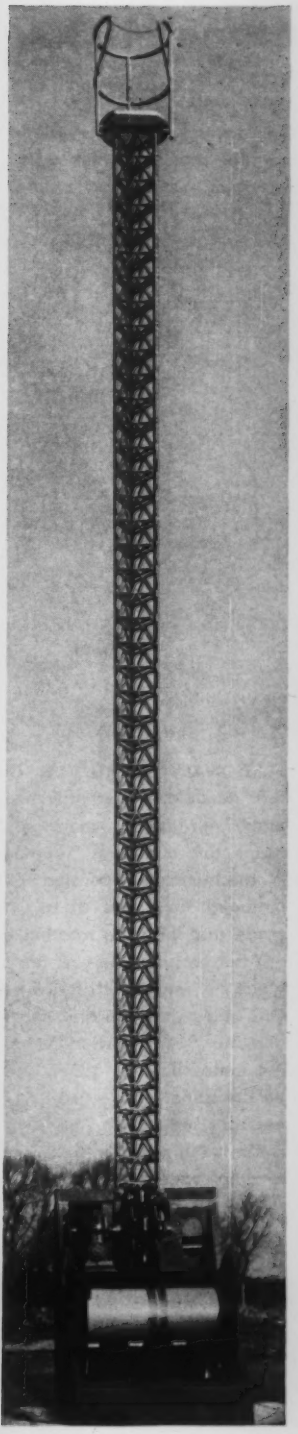
A simple method of providing guide lines to both vanishing points of perspective drawings is furnished by the system shown. If board space is limited a small sketch can be first roughed out with this device, and then enlarged.—JOSEPH E. LESCOVICH, *Golden Anderson Valve Specialty Co., Pittsburgh, Pa.*



Do you have a helpful tip or technique for our other readers? You'll receive ten dollars or more for each published contribution. Send a short description plus drawings, tables, or photos to: Tips and Techniques Editor, MACHINE DESIGN, Penton Bldg., Cleveland 13, O.

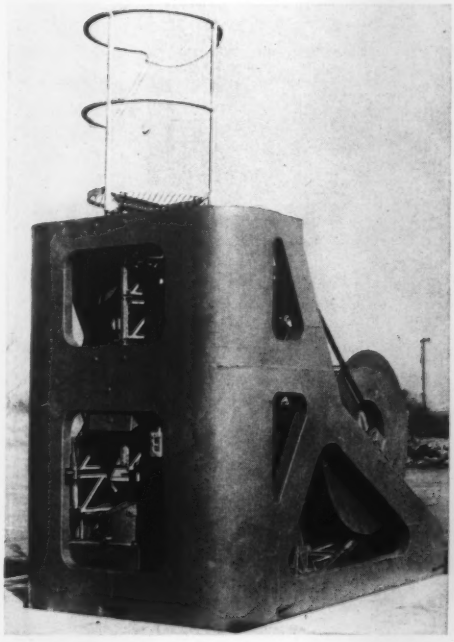
Articulated Chain Forms Triangular Lattice Tower

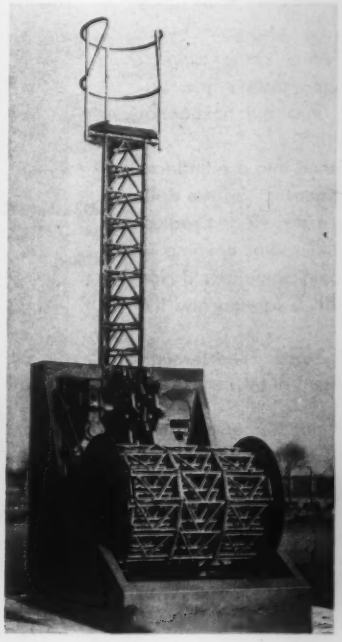
INDIAN ROPE TRICK is performed by articulated chain, consisting of individually hinged components normally wound on a horizontally mounted drum. The chain forms rigid triangular lattice tower capable of lifting a "crow's nest" platform and 1100-lb payload to a height of 50 ft. With bracing wires, a special tower version lifts platform as high as 80 ft. Designed by Michel Le Roy, Paris, France, the lifting speed of the unit is 16½ fpm.



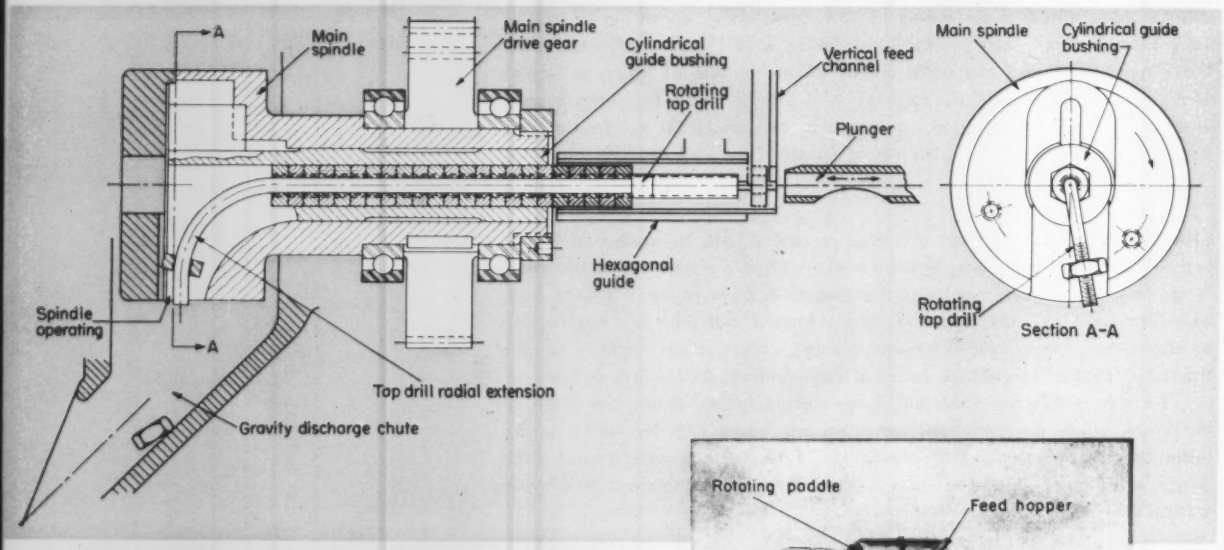
CHAIN COMPONENTS consist of lattice members 15¾ in. wide and 9⅞ in. high. Made of steel tubes, lattice members form a continuous center chain, to which side members are vertically hinged in pairs of two. Lattice members forming a pair are also horizontally hinged, but pairs are independent of each other. Pairs are 19¾ in. high and staggered on opposite sides of the center chain. Hinges are made of high-strength chrome-nickel steel.

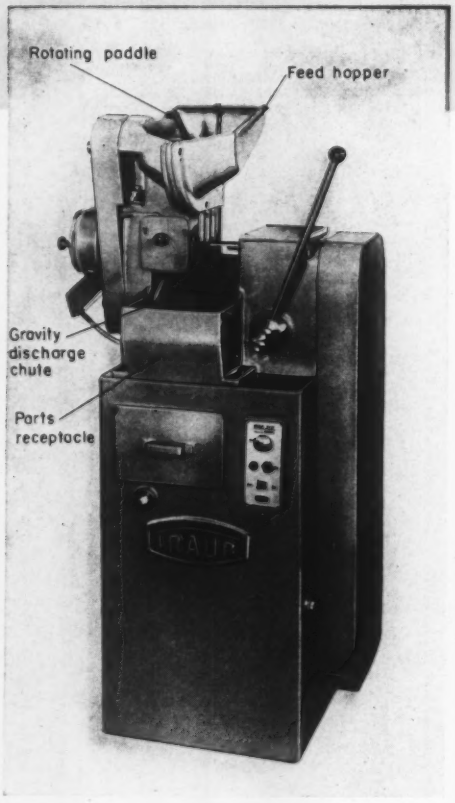
As the pushbutton-operated, 3-hp electric motor draws the chain off the drum, guide members turn successive side pairs 120 deg about vertical tubes of center chain to form triangular tower. Hinge components of opposite side members engage with each other for subsequent interlocking through 60-deg rotation of locking pins.





Floating, Rotating Tap Drill Cuts Breakage in Nut Tapper





STATIONARY HEXAGONAL GUIDE and rotating tap drill make drill breakage nearly impossible in automatic nut-tapping machine. The prismatic guide keeps the nuts from rotating while being tapped. A mechanically operated plunger pushes the unthreaded nuts, one at a time, into the hexagonal guide and onto the rotating tap.

After tapping, the nuts are pushed into a cylindrical guide bushing, which forms a suspension for the drill. One end of the tap drill is bent into a 90-deg radius, and this curved section engages a radial opening in the main spindle. When the main spindle is driven by the spindle drive gear, the drill is rotated and the nuts are tapped.

Threaded nuts are centrifugally discharged through a radial opening in the main spindle into a chute.

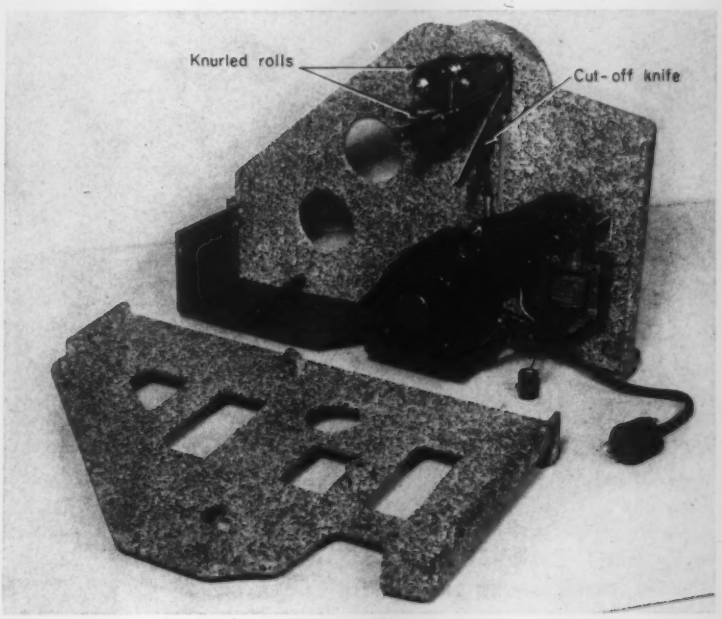
ROTATING PADDLE in hopper of nut tapper positions and feeds nuts into vertical feed channel.

Designed by Hermann Traub, Reichenback-Fils/Wuett., Germany, the machine can be set up to handle square, hexagonal, and octagonal nuts. Hourly production capacities of different models vary from 420 nuts with $\frac{7}{8}$-in. diam threads to 3400 nuts with $\frac{1}{8}$-in. diam threads.

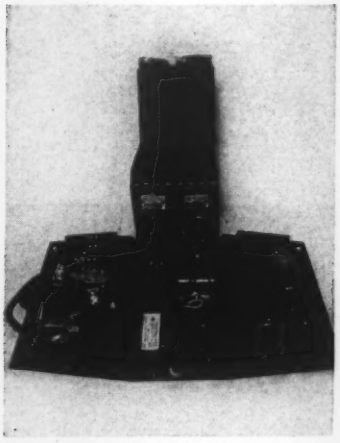
Adjustable Time Delay Controls Gummed-Tape Cut-Off Length

TWO DIFFERENT LENGTHS OF TAPE can automatically be cut off in an electronic tape dispenser. Two separate electronic time delays are used to preset the two desired cut-off lengths. Then either of two buttons can be pushed to dispense and cut tape.

The design was developed by Harold Rabelow, chief engineer, Diagraph-Bradley Industries Inc., Herrin, Ill.



KNURLED TAPE-FEED WHEELS are connected to a 1/50-hp motor by a chain and sprocket drive. The constant-speed drive feeds 40 in. of tape per second. After leaving the storage roll, the gummed tape passes around a small idler roll that reverses the direction of the tape. This travel serves to straighten the tape and also to break the glued side of the tape to permit water to attack it readily.



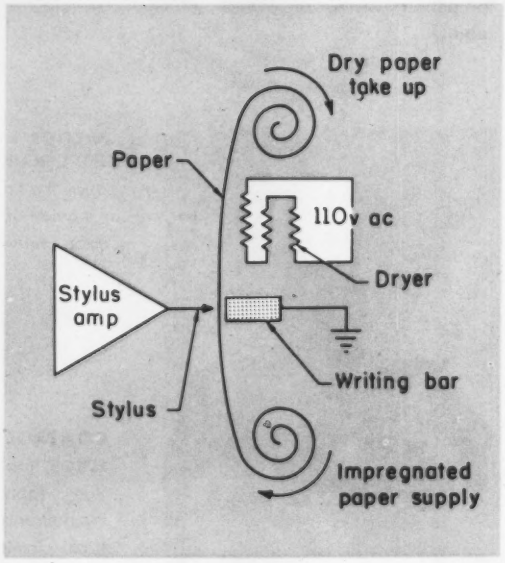
CAPACITOR - RESISTOR BLEED CIRCUITS, which produce the time delays, can provide up to 78 in. of tape delivery.

CONTROL BOX UNFOLDS, making production fabrication and maintenance of the electrical circuit easy.

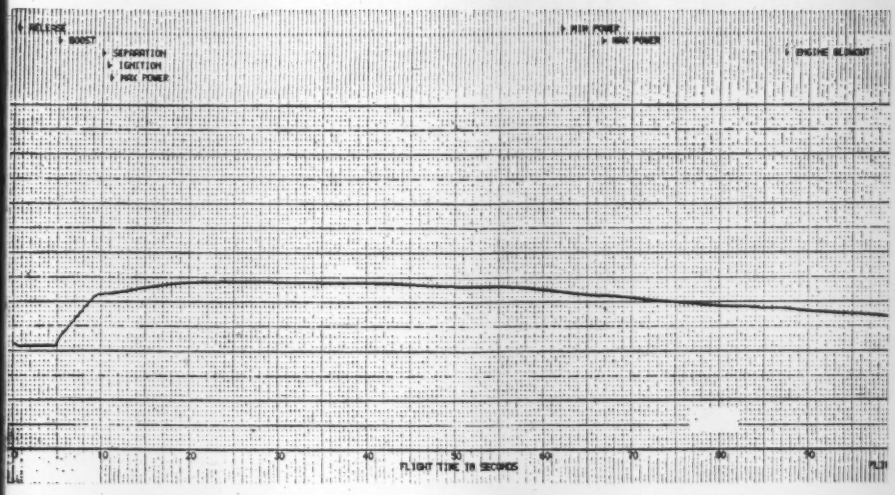
Bank of 1024 Styluses

HIGH-SPEED DIGITAL PLOTTER uses 1024 styluses to convert data on magnetic tape to a printed, graphical form. Maximum information rate is over 4000 data points per second, which are plotted in a dotted-line presentation on 10⅞ in. electrolytic recording paper. An electric signal passing between any one stylus and the writing bar makes a mark by electrolytic deposition of iron from the writing bar to the paper.

The distance between adjacent rows of marks as well as adjacent positions within a single row of dots is 0.01 in.



"Draws" Curves and Prints Data



STYLUSES CAN DRAW X-Y plots, alphanumeric data (lettered and numbered notations), and a co-ordinate system all at the same time at paper speeds from 0.1 to 1 ips.

INPUT DATA fed to the high-speed digital plotter is on ½-in. Mylar tape and can be generated by either IBM or Univac computers. The data tape is played back on an Ampex FR300 tape handler at speeds which allow characters to be read at a burst rate of 20 kc. The recorder is made by Hogan Faximile Inc., New York, N. Y. Transistorized stylus control circuits were designed by Missile and Space Div., Lockheed Aircraft Corp., Sunnyvale, Calif., where the plotting system is installed. The tape-recorded information includes time values followed by one or more associated data values. There can be as many as 40 data points at each specific time increment with a paper speed of 1.0 ips.

Time values must be sequential in increasing order, although the incremental change need not be constant. Paper speed, which represents the time axis, and the internal clock of the plotter, can be adjusted manually to compensate for various minimum time increments.

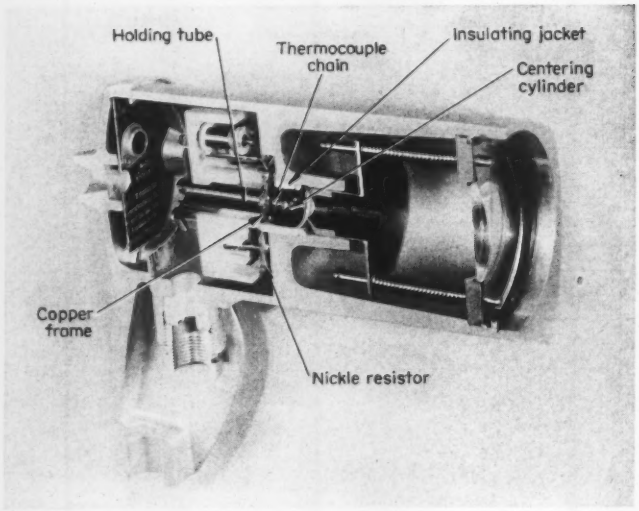
In addition to time and data, the tape includes information to record "time markers" or lines perpendicular to the time axis on the finished plot. These markers are doted lines and can be made at any of several writing densities as specified by the tape code. The time markers constitute part of the co-ordinate system generated by the plotter.

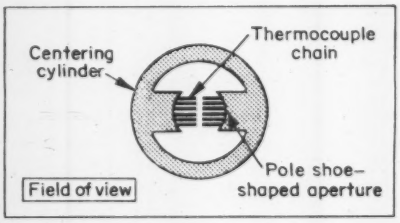
The co-ordinates parallel to the time axis are set up on the patch board.

Improved Thermal, Electrical Layout Ups Radiation Pyrometer Accuracy, Stability

HEAT-CONDUCTING COPPER DISCS frame the thermocouple chain of a radiation pyrometer. This feature, combined with a temperature-compensating nickel resistor, improves measuring accuracy because of higher thermal and electrical stability. Annular discs increase heat transfer between thermochain reference junctions and frame to minimize measuring error resulting from ambient temperature changes. Residual error is compensated for by conventional nickel resistor which, for adequate thermal conductivity, is pressed against interior of cast-aluminum housing by a spring. Insulating materials are temperature-resistant to withstand 360 F without cooling.

Over an ambient temperature increase from 68 to 360 F, measuring error is only 5 to 15 F, depending on the measuring range. This error is within the accuracy of calibration, which is somewhat better than 1 per cent or approximately 25 F for a 3600 F measurement.



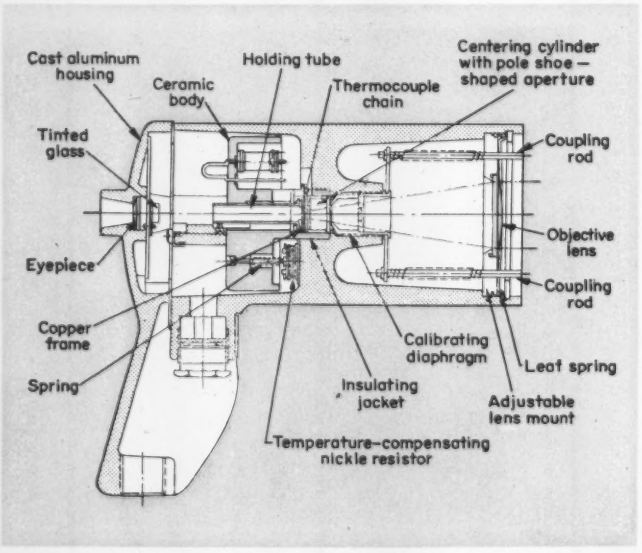


ELEVEN-PIECE THERMOCHAIN is composed of NiCr-constantan elements. Copper frame is centered by cylinder containing pole shoe-shaped aperture. Although the aperture properly limits incoming radiation to make measurements sufficiently independent of distance, it considerably increases the field of view required for aiming at the radiating body.

Centering cylinder is surrounded by an insulating ceramic jacket. Holding tube positions thermochain insert in ceramic body accommodating terminals and additional resistors.

Calibrating diaphragm is screwed into housing and adjusted through rotatable lens mount and coupling rods.

. The design is by Siemens & Halske AG, Karlsruhe, Germany.



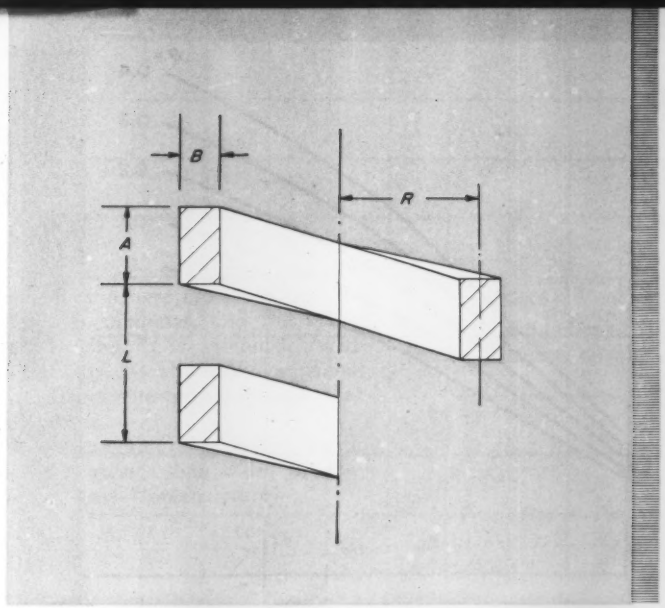


Fig. 1—Basic details of helical spring with rectangular section.

Designing for zero end torque or rotation in

Helical Springs

W. J. BARMORE
Chief Engineer
Instrument Div.
Genisco Inc.
Los Angeles, Calif.

WHEN a round-wire helical spring is extended or compressed, certain force components cause elements of the spring to rotate about the spring axis. This rotation, and stresses produced by forces which restrain it, are detrimental in many precision mechanisms.

Analysis of spring force components shows that the amount of end rotation can be controlled by varying the geometry of the wire cross section. This rotation can be made zero by using a rectangular cross section of certain proportions.

Basic Relationships: Two components of motion combine to produce rotation. One is due to the torsion of an element of the spring, and the other is due to the flexure of that element. These two components act in opposite directions, and their rela-

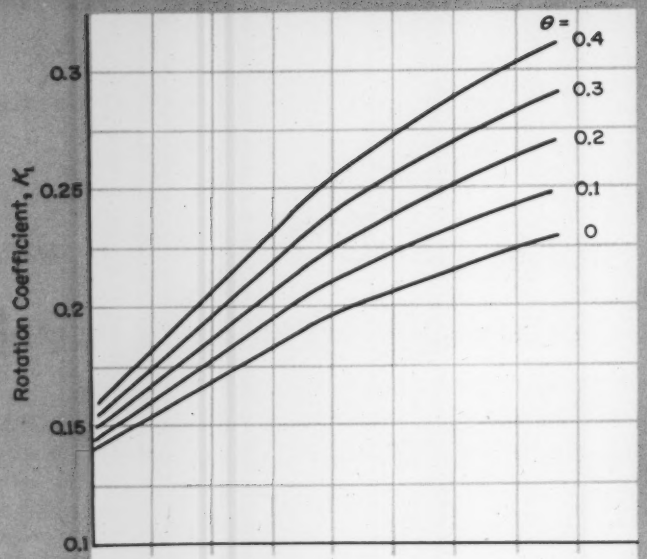


Fig. 2 — Spring-rotation coefficient vs. spring-section proportions for different values of factor θ.

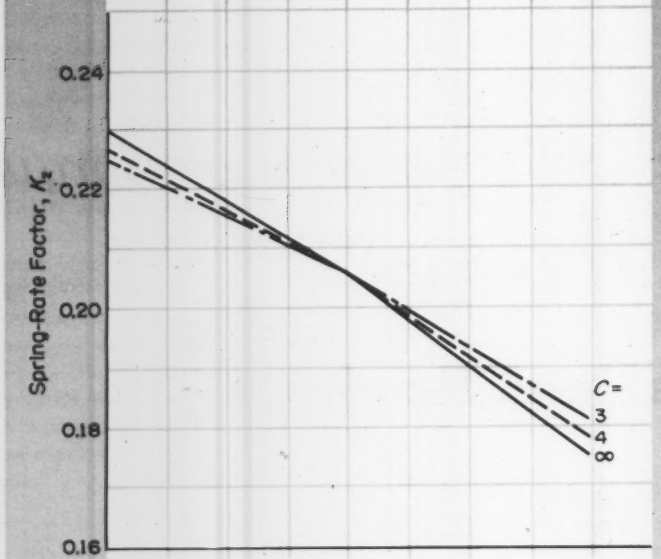


Fig. 3 — Spring-rate factor vs. spring-section proportions for different values of spring index.

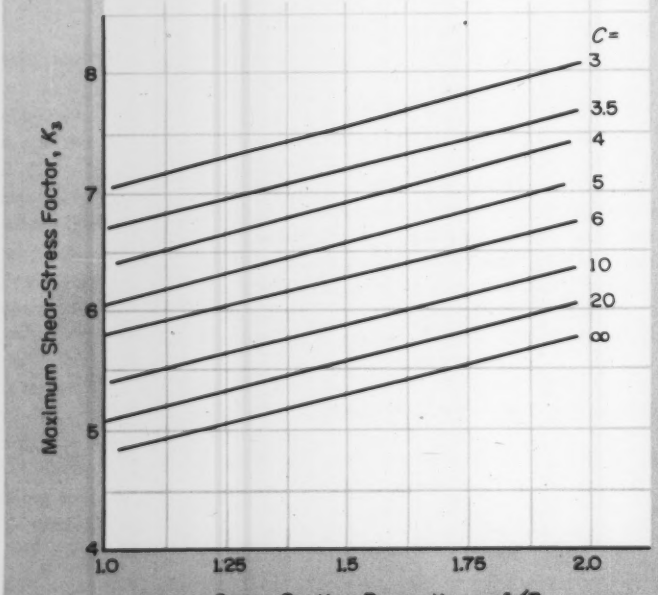


Fig. 4—Spring shear-stress factor vs. spring-section proportions for different values of spring index.

tive magnitudes vary for wire with different cross sections. With round or square cross sections, the torsional component predominates, and the spring tends to coil tighter when it is extended. With rectangular cross sections, the flexural component can be increased relative to the torsional component until net rotation is zero.

For springs with a rectangular cross section, Fig. 1, in which thickness A is greater than width B, rotation per unit load is (see Nomenclature)

$$\frac{\phi}{P} = 2\pi \left(\frac{R^2 N \sin \alpha}{GB^3 A} \right) \left(\frac{1}{K_1} - \frac{12G}{E} \right) \quad (1)$$

where

$$K_1 = K_4 + \frac{K_5 \cos^4 \alpha}{C^2 - 1} \quad (2)$$

Constants K_4 and K_5 in this expression are empirical functions of ratio A/B. Therefore, a spring will have zero rotation if

$$K_1 = \frac{E}{12G}$$

Coefficient K_1 may be determined from Fig. 2, where it is plotted as a function of ratio A/B for various values of θ. Factor θ, in turn, is a function of helix angle α and spring index C, as will be shown (Equation 6). Values of modulus of rigidity and ratio $E/12G$ are given in Table 1 for certain common spring materials. For other materials, ratio $E/12G$ may be evaluated directly from the relationship, $E/12G = (1 + \nu)/6$.

To simplify design calculations, spring-rate factor K_2 and maximum shear-stress factor K_3 are plotted in Fig. 3 and 4, respectively, as functions of spring dimensions.

Design Procedure: With these graphs, a spring of given rate can be designed by following these steps:

1. Choose R and B, assume $A/B = 1.5$, and calculate $C = 2R/B$.

2. Calculate the number of turns, N, using Fig. 3 and

$$k = K_2 \left[\frac{G(AB)^2}{R^3 N} \right] \quad (3)$$

3. Determine the stress, τ, using Fig. 4 and

$$\tau = K_3 \left[\frac{PR}{(AB)^{3/2}} \right] \quad (4)$$

4. If the number of turns and the stress are satisfactory, calculate helix angle α and the value of θ from

$$\tan \alpha = \frac{L}{2\pi R} \quad (5)$$

$$\theta = \frac{\cos^4 \alpha}{C^2 - 1} \quad (6)$$

5. From Fig. 2, find the value of A/B corresponding to $K_1 = E/12G$ and the previously calculated value of θ.

Table 1—Material Constants for Spring Calculations

Material	$E/12G$	$G/10^6$ (psi)
Spring steel	0.218	11.5
18-8 stainless steel	0.212	11.0
Phosphor bronze	0.198	6.3
Beryllium copper	0.214	7.0
Ni-Span C	0.234	9.8

Nomenclature

- A = Cross-section thickness, in.
- B = Cross-section width, in.
- C = Spring index $= 2R/B$
- E = Modulus of elasticity, psi
- F = Free length of spring, in.
- G = Modulus of rigidity, psi
- K_1 = Rotation coefficient (Equation 2)
- K_2 = Spring-rate factor (Equation 3)
- K_3 = Maximum shear-stress factor (Equation 4)
- K_4, K_5 = Dimensional factors (Equation 2)
- k = Spring rate, lb per in.
- L = Lead, in.
- N = Number of active turns
- P = Load, lb
- R = Mean coil radius, in.
- α = Helix angle (Equation 5)
- θ = Dimensional factor (Equation 6)
- τ = Maximum shear stress, psi
- ν = Poisson's ratio
- ϕ = Angle of rotation, rad.

6. If this value differs significantly from the assumed value of A/B in step 1, repeat steps 1 through 5, using another value of A/B. To obtain zero spring rotation, the value of A/B assumed in step 1 must equal the value of A/B obtained in step 5.

This procedure is recommended for the general design situation in which free length is governed by space requirements. However, if free length is not limited by other application criteria, the following alternative procedure may be used in design:

1. Choose R, B, and L, and calculate α and θ from Equations 5 and 6.
2. Find the value of A/B, corresponding to $K_1 = E/12G$, from Fig. 2.

3. Calculate N, using Fig. 3, and determine free length F.
4. If the value of F is satisfactory, check stress value using Fig. 4.

Design Example: A beryllium-copper compression spring is required for use where rotation between the ends is detrimental. Fixed parameters are: Spring rate $k = 0.9$ lb per in.; ID of coil $= 0.40$ in.; free length $F = 1.0$ in.; and maximum load $P = 0.2$ lb.

The general procedure will be used. As a first trial, assume A/B, $= 1.5$ and $B = 0.02$ in. Therefore: $A = 0.03$ in., $R = 0.21$ in., and $C = 21$.

From Fig. 3, $K_2 = 0.0206$. From Equation 3, then,

$$N = \left(\frac{0.0206}{0.9}\right)\frac{(7)(10^6)[(0.03)(0.02)]^2}{0.21^3} = 6.23$$

From Fig. 4, $K_3 = 5.6$ and, from Equation 4, stress at maximum load is

$$\tau = 5.6\,\frac{(0.2)(0.21)}{[(0.03)(0.02)]^{3/2}} = 16{,}000 \text{ psi}$$

These values for number of turns and stress are satisfactory. Therefore, assuming free length F includes one dead coil to provide for squaring of ends,

$$L = \frac{F - A}{N} = \frac{1.00 - 0.03}{6.23} = 0.156 \text{ in.}$$

From Equations 5 and 6

$$\alpha = \tan^{-1}\frac{0.156}{(2\pi)(0.21)} = 6 \text{ deg } 44 \text{ min}$$

$$\theta = \frac{0.9931^4}{21^2 - 1} = 0.00221 \text{ rad}$$

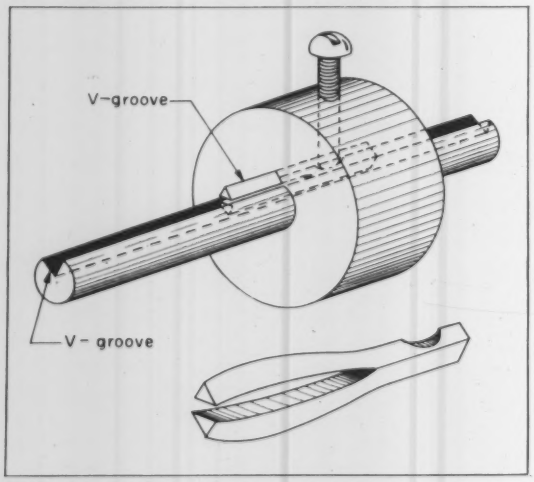
Table 1 gives $E/12G = 0.214$ for beryllium copper. From Fig. 2, A/B should be 1.78 for zero rotation. A second trial will be required.

Let $A = 1.78B$ or 0.0356 in. Other calculated values are: $N = 8.78$, $\tau = 12{,}400$ psi, $L = 0.110$ in., $\alpha = 4$ deg 46 min, and $\theta = 0.00224$ rad. Now, from Fig. 2, A/B should be 1.78 which is the same value assumed for second trial. Therefore, $A = 0.0356$ in. and $B = 0.020$ in. form the correct cross section for zero rotation.

Tips and Techniques

Spring Key

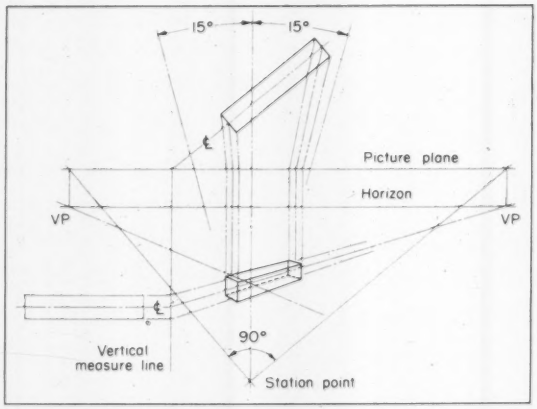
A key which prevents rotation while allowing sliding can be made from square rod or wire, slotted and sprung to provide the desired friction.—GARRY W. KLEES, *Chrysler Corp., Farmington, Mich.*



Pictorial Views

Pictorial views depicted in standard orthographic projections can be simply and accurately rendered by the following procedure:

1. Scissor out plan and side views from conventional print. Fasten plan view within 15 deg of vertical through station point.
2. Locate station point on vertical near base of drawing.



3. Establish picture plane and horizon lines. Project center line of plan view to picture plane.
4. Project vertical measuring line as shown. Fasten side view to left of vertical measuring line.
5. Locate vanishing points on horizon by verticals from picture plane, and lines drawn from station point at 90 deg or less.
6. Project points from both views to complete pictorial rendering.—CHARLES E. MATHAY, *test engineer, Thompson Ramo Wooldridge Inc., Cleveland, Ohio.*

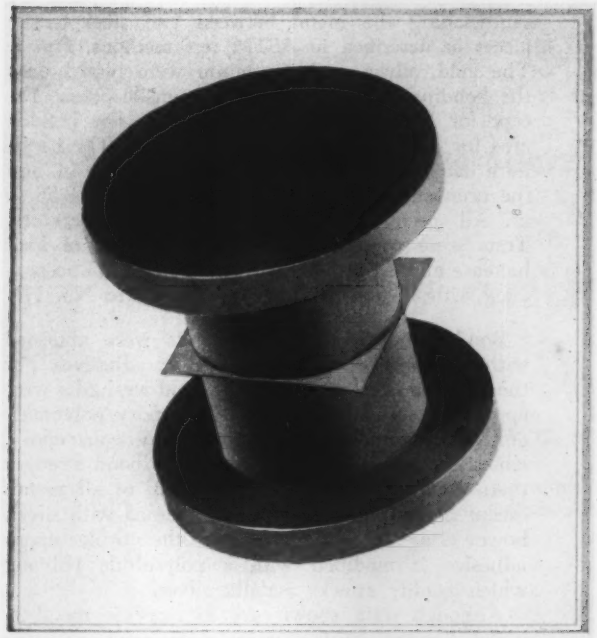


Fig. 1 — Tensile specimen for adhesion test method. Metallic foil is sandwiched between the tensile pieces.

What tests show about tensile strengths of adhesive bonds between uncommon metals

Bonding Rare Metals

R. F. WEGMAN and M. J. BODNAR
Organic Chemist Materials Engineer
Plastic and Adhesives Research Sec.
Picatinny Arsenal
Dover, N. J.

MANY rare and unusual metals have outstanding heat resistance and chemical stability. Where applications of these materials require smooth surfaces free from irregularities, adhesive bonding is generally specified. Results of adhesion tests with these metals are of special interest since bondability data are not readily available.

Steel specimens were bonded to beryllium, columbium (niobium), copper-beryllium alloy, molybdenum, palladium, rhenium, stainless steel, tantalum, tungsten, uranium, zirconium, and 720 alloy (manganese-copper-nickel). Also, chromium, gold, silver, stainless steel, and titanium were bonded to themselves. Tensile strength of the bonds is shown in Table 1.

Degree of adhesion obtainable also indicates the success that can be expected when polymeric materials are used as sealants or encapsulating compounds with these metals. Penetration of moisture through a sealed area depends not only on the moisture resistance of the sealant and adherend but also on the extent to which the moisture can penetrate the interface area between the sealant and adherend. Generally, if a low degree of adhesion is experienced between two surfaces, moisture may conceivably penetrate the sealed joint through microscopic voids.

Metal Preparation: No special cleaning procedure was used to prepare the metal surfaces. The specimens, with certain exceptions, were vapor degreased with perchloroethylene before applying the adhesive. The exceptions were beryllium, uranium, stainless steel (for bonding to itself), and titanium. Beryllium and uranium form oxides which were removed by special abrading processes developed at Picatinny Arsenal. Stainless steel and titanium were treated by cleaning with a dilute chromic-acid solution.

Adhesives: Two types of adhesives, a rigid polyester and a filled novolac epoxy, were used to bond all specimens except the uranium-steel combination, Table 1. Because of the special problem involved in bonding to uranium, two other adhesives were selected as a result of successful adhesion achieved in long-term storage tests. These were an epoxy modified with a polyamide and a polyurethane.

Test Specimens: In all cases where the rare metals

Table 1—Adhesive-Bond Strength at 73.5 F

Bonded Materials	Adhesive*	Tensile Strength (psi)
Steel to:		
Beryllium	A	4820
	B	4640
Columbium	A	5010
	B	3400
Copper-beryllium	A	6240
	B	3940
Molybdenum	A	4840
	B	4575
Palladium	A	5200
	B	4315
Rhenium	A	6410
	B	3235
Tantalum	A	4100
	B	3300
Tungsten	A	5470
	B	5025
Uranium 238	C	1184
	D	1300
Zirconium	A	5490
	B	3590
720 Alloy	A	3600
	B	3135
Metals to themselves:		
Chromium	A	7160
	B	5010
Gold	A	8610
	B	3950
Silver	A	3780
	B	5625
Stainless Steel 347	A	8500
	B	6070
Titanium	A	9920
	B	5665

*Adhesive	Name	Description	Supplier
A	Epiphen 825A	Modified, filled, epoxylated novolac	The Borden Chemical Co.
B	Laminac 4116	Rigid, modified polyester	American Cyanamid Co.
C	Epon 828/Versamid 115	Bisphenol A-epichlorhydrin epoxy modified with a polyamide	Epon, Shell Chemical Corp.; Versamid, General Mills Inc.
D	Adiprene L	4, 4′ Methylene bis (2-chloroaniline) cured polyethane	E. I. du Pont de Nemours & Co. Inc.

were bonded to steel, specimens were prepared by sandwiching the metal between two steel tensile pieces as described in ASTM test methods, Fig. 1. The gold, silver, and chromium were plated onto the bonding surfaces of standard tensile pieces. Except for the beryllium and uranium, the bonded area for each test specimen was 1 sq in. The beryllium had a surface bonding area of 0.785 sq in. and the uranium had a surface bonding area of 0.56 sq in. All specimens were cured at room temperature. Tests were conducted at a constant rate of load increase applied at 600 to 700 psi per min in accordance with Federal Test Method Standard No. 175.

Bonds Obtainable: Good bonds were obtained with the polyester and novolac epoxy adhesives. For the uranium-steel combination, bond strengths were approximately the same for the epoxy/polyamide and the polyurethane adhesives. The novolac epoxy, adhesive A, Table 1, provides higher bond strength than the rigid polyester, adhesive B, to all metals except silver. The lower results obtained with silver, however, are to be expected since the novolac epoxy adhesive is modified with a polysulfide polymer which readily attacks metallic silver.

Although data shown are for specific metal-to-metal bonded joints, approximate bond strengths obtainable can be calculated for any combination of the metals reported here. For example, if columbium were bonded to gold, the results would be expected to be no better than the adhesion to columbium. At room temperature, the bond strength obtained will always be equal to the bond strength obtainable to the metal with the lowest surface adhesion properties. At other temperatures, differences in thermal coefficients of expansion may have to be considered.

ACKNOWLEDGMENT

The author acknowledges with appreciation the co-operation of Mr. E. A. Jenstrom of the Fansteel Metallurgical Corp., Mr. John Veliky, and Mr. Edward Duda.

They Say . . .

"Mathematics is the central directive agent of the whole human quest for quantitative understanding of the environment. It is in command at all points in man's efforts to apply nature to his advantage. It is the medium through which chaos and superstition are banished. It is the backbone not of one science or of several, but of all science . . . ."—RUDOLPH E. LANGER, *director U. S. Army Mathematics Research Center, Univ. of Wisconsin.*

"Our political, our economic, and our social systems flourish when we discipline ourselves not only to accept responsibilities but to strive for the highest excellence in our personal achievements, and when we recognize by public acclaim and position those who achieve that excellence. Engineers have no greater right to acclaim than others of our citizenry. By the very nature of their training and their work, however, they have developed mental discipline which entails a responsibility to put that discipline to work."—JOSEPH W. BARKER, *chairman of the board, Research Corp., New York, N. Y.*

DESIGN MANUAL : Cast Bronze Sleeve Bearings/No. 2

Viscosity and Lubricants

HARRY C. RIPPEL
Senior Research Engineer
The Franklin Institute Laboratories
Philadelphia

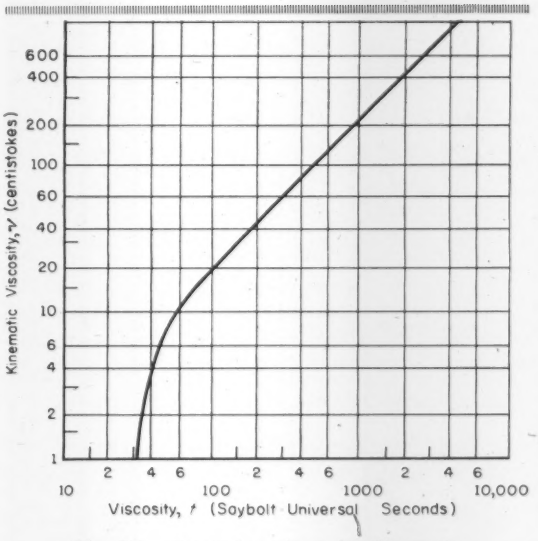


Fig. 26 — Conversion chart for kinematic viscosity and Saybolt viscosity.

THERE are so many methods of measuring viscosity of fluids that viscosity data can be quite confusing to a designer of bearings. To clarify the "mystery" surrounding viscosity information, simple definitions which follow present a clear picture of common terms and units. A step-by-step procedure shows how to calculate absolute viscosity, which is used for bronze sleeve bearing design.

Deciding which lubricant to use for full, mixed, or boundary-film lubrication can also be a problem. Discussion of factors to consider and a lubricant-selection chart help remove this obstacle.

Under certain conditions, oils may not provide satisfactory lubrication. Other lubricants must then be used. Descriptions of various greases and solid lubricants serve as a helpful reference when departting from conventional oils.

Design fundamentals appeared in the September 17 issue of MACHINE DESIGN as Part 1 in this planned program of six articles. The entire Design Manual was prepared by The Franklin Institute Laboratories as part of a program sponsored by Cast Bronze Bearing Institute.

Nomenclature

B = Constant for Equation 31 (Table 6)
e = Base of natural logarithms = 2.718
p = Pressure, psi
T = Temperature, F
t = Viscosity, Saybolt Universal Seconds (SUS)
W = Steady load to be supported, lb
Z = Lubricant absolute viscosity, centipoises
ν = Kinematic viscosity, centistokes
ρ = Specific gravity, or mass density, of oil, gm per cu cm
ρ_{API} = API gravity at 60 F, degrees

▶ Lubricant Viscosity

To the designer of a fluid-film bronze bearing, viscosity of the lubricant is its most important single physical property. Viscosity dictates load-carrying capacity, fluid-film thickness, operating temperature, and friction loss in the bearing.

Viscosity is defined as the internal frictional resistance offered by a fluid to any change in shape or relative motion of its parts. For example, because water pours more readily than oil, oil is said to be more viscous than water. Properly designed, bronze bearings can, and do, operate using "fluids" having viscosities that cover a range represented by

air and honey. Even a typical lubricating oil such as SAE 30 exhibits a 50-fold change in viscosity over its normal operating temperature range.

Various measures of viscosity and specific gravity are defined in Table 4.

Viscosity Variation with Temperature: If Saybolt viscometer data are available at two different temperatures, Saybolt viscosity at any other temperature can be determined from a plot of this information on special graph paper. Data for a typical SAE 30 oil are plotted in Fig. 27 on graph paper obtainable from American Society for Testing Materials.

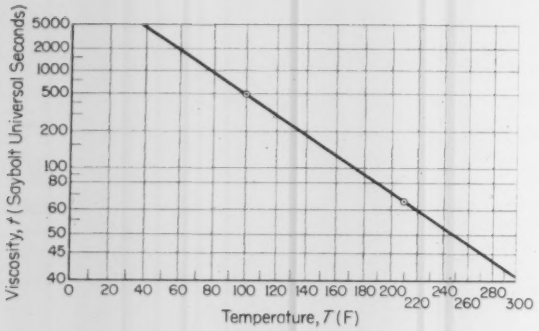


Fig. 27—Relationship of Saybolt viscosity and temperature for SAE 30 oil on sample of special ASTM graph paper. Line is determined by: 489 SUS at 100 F, and 65 SUS at 210 F. API gravity is 28.7 deg at 60 F.

A straight line drawn between the two data points gives a curve of t versus T for an appreciable temperature range. Saybolt viscosity t at any other temperature, T, can then be determined from the graph.

Calculating Absolute Viscosity: If specific gravity at a particular temperature and kinematic viscosity at the same temperature are known, absolute viscosity at that temperature can be computed. The sequence of operations is presented in Table 5 with given and calculated values indicated. Absolute viscosity can also be obtained from Fig. 28 if Saybolt viscosity and specific gravity have been determined. A chart similar to Fig. 28 can be plotted for Equation 30 if the designer finds it convenient.

Computations indicated in Table 5 were made for several SAE lubricants, and results are plotted in Fig. 29 for temperature T. These curves are only typical, and there may be (and, in fact, there is) considerable difference in viscosity-temperature relationship for the same SAE grade oil made by different companies. If sufficient data are available on the lubricant to be used, calculation of the absolute viscosity-temperature relationship outlined in Table 5 and a plot similar to Fig. 29 are recommended.

Viscosity Index: Quite often, the term "viscosity index" is used in lubrication practice to denote an arbitrary system of comparison used in evaluating

Table 4—Viscosity and Specific Gravity Definitions

Specific Gravity: Standard practice in the oil industry is to obtain a measure of specific gravity at 60 F on an arbitrary scale specified by American Petroleum Institute. As an example, API gravity may be expressed as "27.5 degrees at 60 F."

The relation between API degrees and specific gravity at 60 F is

$$\rho_{60} = \frac{141.5}{131.5 + \rho_{API}} \qquad (27)$$

Specific gravity, or grams of mass per cubic centimeter, at some other temperature, T, is found from

$$\rho_T = \rho_{60} - 0.00035(T - 60) \qquad (28)$$

Normal values of specific gravity for sleeve-bearing lubricants range from 0.75 to 0.95. Hence, if the API rating is not known, an assumed value of 0.85 may be used.

Saybolt Viscosity: A standard method established by American Society for Testing Materials is used by the oil industry to determine viscosity. The method requires determination of the time required for 60 cu cm of constant-temperature oil to flow through a tube 0.176 cm in diameter and 1.225 in. long. The instrument used to determine viscosity is the Saybolt Universal Viscometer, which may give such viscosity information as: 450 SUS (Saybolt Universal Seconds) at 100 F. This reading means the lubricant in question required 450 seconds to pass 60 cu cm through the Saybolt Universal Viscometer at 100 F.

Kinematic Viscosity: To an experienced lubricant man, SUS rating may be meaningful, but it is useless for computational purposes. A more meaningful measure of viscosity is obtained from

$$\nu = 0.22t - \frac{180}{t} \qquad (29)$$

where ν is the kinematic viscosity in centistokes and t is the number of seconds obtained from the Saybolt Universal Viscometer. For convenience, the curve of Equation 29 is plotted in Fig. 26.

Absolute Viscosity: Mass density of the oil must be introduced to obtain absolute viscosity:

$$Z = \rho\nu \qquad (30)$$

Absolute viscosity is expressed in centipoises, with 1 centipoise being equivalent to 0.01 gram of mass per centimeter per second. Mass density in metric units is equal to specific gravity.

Table 5--Calculation of Absolute Viscosity Z

Step	Symbol		Calculation	Value
1.	ρ_{API}	Degrees API at 60F	Given	——, degrees API
2.	ρ_{60}	Specific gravity	$141.5/(131.5+\rho_{API})$	——, gm/cu cm
3.	T	Temperature	Selected	——, F
4.	ρ_T	Specific gravity	$\rho_{60}-0.00035(T-60)$	——, gm/cu cm
5.	t	Saybolt viscosity at T	Given	——, SUS
6.	ν_T	Kinematic viscosity	$0.22t-180/t$	——, centistokes
7.	Z_T	Absolute viscosity	$\rho_T \nu_T$, or from Fig.28	——, centipoises

the relationship between viscosity and temperature. At one time it served the very useful purpose of identifying the source of an oil. Lately, it has fallen into disuse because modern developments have improved viscosity-temperature relationships. However, the index is still valuable, within limits, for expressing relative change of viscosity with temperature.

Graphical means for evaluating the viscosity index are provided by Fig. 30. Use of this chart is explained with the typical SAE 30 oil plotted in Fig. 27 as an example. Enter Fig. 30 on the horizontal scale for a Saybolt viscosity of 489 sec at 100 F. Move vertically to the Saybolt viscosity of 65 sec at 210 F, interpolating this point between the slanting lines. Then move horizontally and read 106 as the VI rating on the vertical scale.

In general, oil having a high VI has a better temperature-viscosity relationship than oil with a low VI—better in the sense that rate of change of viscosity with temperature is less.

Viscosity Variation with Pressure: Many ordinary lubricants are known to undergo appreciable increase in viscosity when subjected to high pressure. In highly loaded bronze bearings, where $W/LD >$ 1000, peak fluid pressures ranging from 10,000 to 20,000 psi are possible. Hence, the pressure effect on viscosity can be considerable. Fortunately for

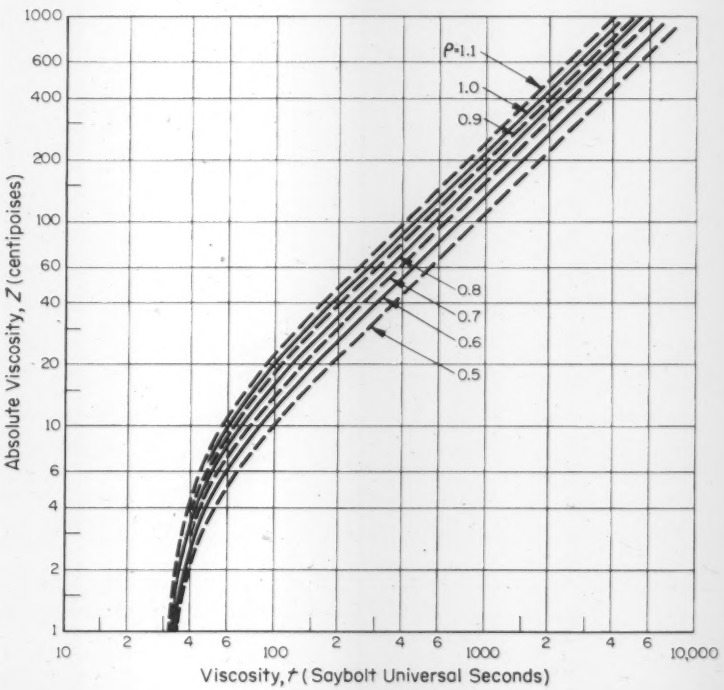


Fig. 28 — Conversion chart for absolute viscosity and Saybolt viscosity for different values of specific gravity.

the sleeve bearing, pressure causes an increase in viscosity such that load-carrying capacity of the bearing is increased.

An approximate expression that determines the new viscosity, Z_p, caused by pressure p is

$$Z_p = Ze^{Bp} \qquad (31)$$

where e is a constant equal to 2.718 and Z is absolute viscosity at atmospheric pressure. Values of B for various lubricants are given in Table 6. However, the effect of increased viscosity as a result of pressure need not ordinarily be introduced.

Lubricant Selection

Criteria for selecting bronze bearing lubricants are: 1. Journal speed. 2. Anticipated operation—that is, whether the bearing will operate on a full, mixed, or boundary film. 3. Unit load. As a guide to lubricant selection, Fig. 31 combines these factors with horizontal bands representing the recommended SAE lubricant.

For example, consider a lightly loaded journal operating under full-film conditions at 1000 rpm. Move vertically in Fig. 31 for a speed of 1000 rpm. The slanting line for light load, full-film lubrication is intersected in the middle of the band for SAE 10 oil. If the journal were operating under a heavy load, an SAE 20 oil would be recommended by the chart.

In general, heavier oils—those with higher SAE numbers — are recommended for higher loads. Heavier oils should also be used for boundary and mixed-film operation. Grease lubrication is suggested when lubricants heavier than SAE 50 are required. When operating temperatures are high, oils heavier

Table 6—Values of *B*

Lubricant	Viscosity (centipoises)	Temperature (F)	*B*
Steam cylinder oil	442	130	1.69×10^{-4}
Light turbine oil	30	100	1.37
Kerosene	1.9	81	0.75
Castor oil	266	100	1.01
Glycerine	200	94	0.40
Olive oil	40	115	0.77
SAE 10	40	100	1.73
SAE 10	7	180	1.45
SAE 20 (high VI)	56	100	1.53
SAE 20 (high VI)	10.6	180	1.26
SAE 20 (low VI)	77	100	1.90
SAE 20 (low VI)	11.7	180	1.37
SAE 30	105	100	2.2×10^{-4}

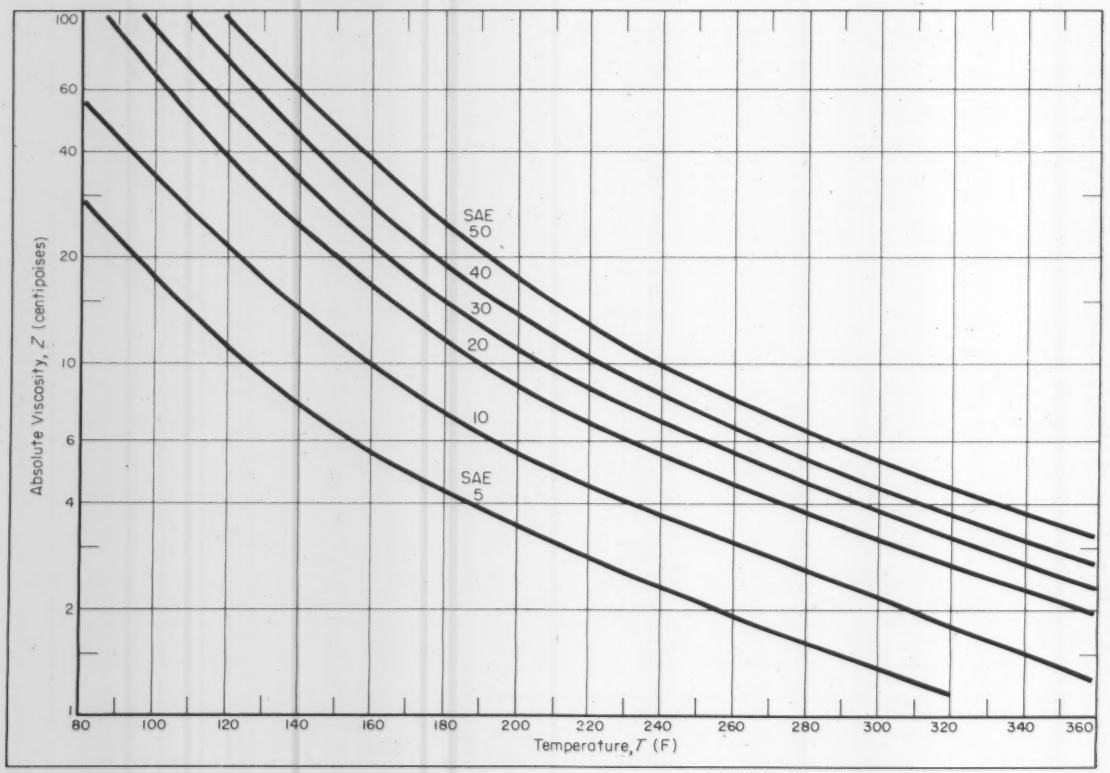


Fig. 29—Average absolute viscosities of typical SAE motor oils for normal temperature range.

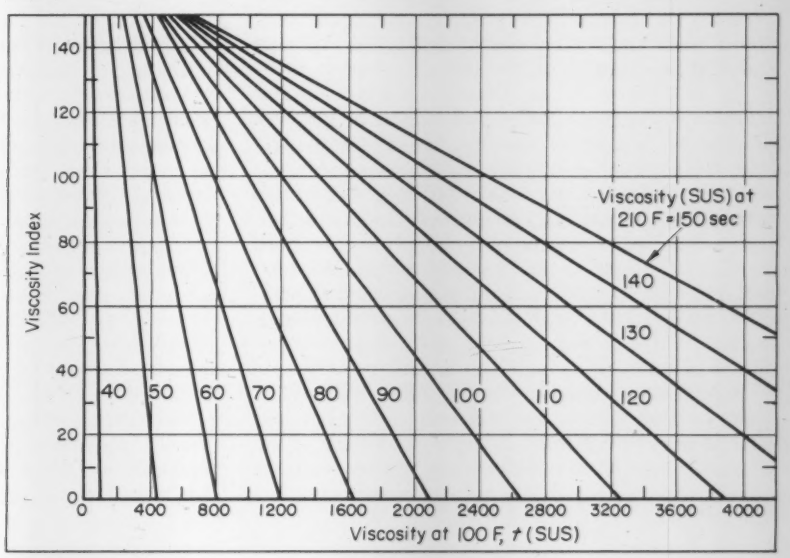


Fig. 30—Viscosity index as determined by two Saybolt viscosities at standard temperatures of 100 and 210 F.

than indicated on the chart should be used, and for bearings more than 3 in. in diameter, lighter oils than indicated are recommended. Thus, although Fig. 31 is a useful guide, certain situations may require violation of the charted suggestions.

Greases and Solid Lubricants

In addition to lubricating oils, many other commercial lubricants are available for use in bronze bearings. Reasons for using other lubricants are varied, but several important reasons are to:

1. Lengthen the period between relubrication.
2. Avoid contaminating surrounding equipment or material with "leaking" lubricating oil.
3. Provide effective lubrication under extreme temperature ranges.
4. Provide effective lubrication in the presence of contaminating atmospheres.
5. Prevent intimate metal-to-metal contact under conditions of high unit pressures which might destroy boundary lubricating films.

Lubricants which can meet some or all of these con-

Table 7—Common Greases and Solid Lubricants

Lubricant Type	Appearance or Structure	Solubility in Water	Recommended Operating Temperature	Operating Loads	Comments
Greases					
Calcium soap, or lime soap	Smooth, buttery	Insoluble	160 F max	Moderate	—
Sodium soap, or soda base	Fibrous texture	Soluble	300 F max	Wide range	For wide speed range. Possible oil separation above 350 F.
Aluminum soap	Smooth, salve-like	Insoluble	180 F max	Moderate	—
Lithium soap base	Smooth	Semisoluble	300 F max	Moderate	Good for low temperatures.
Barium soap	Short fibers	Insoluble	350 F max	Wide range	Multipurpose grease. Similar to lithium soap base grease.
Solid Lubricants					
Graphite	Powder or flakes	Insoluble	1000 F max	Wide range	Chemically inert. Mixes readily with oil or grease.
Molybdenum disulfide	Powder	Insoluble	− 100 to 750 F	Wide range	Chemically inert. Resists attack by water, oil, alkalies, and most acids.

ditions fall into two major classifications—greases and solid lubricants.

Greases: Where full-film lubrication is not possible or is impractical for slow speed, fairly high-load applications, greases are widely used as bronze-bearing lubricants. Although full-film lubrication with grease is possible, an elaborate pumping system is required to continuously supply a prescribed amount of grease to the bearing. Bronze bearings supplied with grease are usually lubricated periodically. Hence, for this discussion, grease lubrication implies that the bearing will operate under conditions of complete boundary lubrication and should be designed accordingly.

Lubricating greases are essentially a combination of a mineral lubricating oil and a thickening agent, which is usually a metallic soap. When suitably mixed, they make excellent bronze-bearing lubricants. There are many different types of greases which, in general, may be classified according to the soap base used. Information on the most common greases is charted in Table 7.

Synthetic greases are composed of normal types of soaps but use synthetic hydrocarbons instead of normal mineral oils. Available in many consistency ranges in both water-soluble and insoluble types, synthetic greases are capable of wide variations in operating temperature.

Additives for lubricating greases, such as oxidation inhibitors and extreme-pressure additives, are available. Greases can be fortified with fillers such as mica, lead, zinc, carbon black, or graphite to enhance their lubricating quality. Such fillers are of advantage under extremely heavy loads or intermittent motion. Because certain additives and fillers may adversely affect bearing or journal material, they should be selected with care. Cast bronzes are not affected by mild EP additives, but highly active additives require caution. Final recommendations on special-purpose greases should be obtained from the lubricant manufacturer.

Application of grease is accomplished by one of several different techniques determined by grease consistency. National Lubricating Grease Institute has classified greases by their consistency and assigned NLGI consistency numbers to them. This classification is shown in Table 8 along with typical methods of application. Grooves for grease are generally greater in width, up to 1.5 times, than for oil.

Coefficients of friction for grease-lubricated bearings range from 0.08 to 0.16, depending upon consistency of the grease, frequency of lubrication, and type of grease. An average value of 0.12 may be used for design purposes.

Table 8—NLGI Consistency Numbers

NLGI Consistency No.	Consistency of Grease	Typical Method of Application
0	Semifluid	Brush or gun
1	Very soft	Pin-type cup or gun
2	Soft	Pressure gun or centralized pressure system
3	Light cup grease	
4	Medium cup grease	
5	Heavy cup grease	Pressure gun or hand
6	Block grease	Hand, cut to fit

Solid Lubricants: The need for effective high-temperature lubricants led to development of several solid lubricants. Essentially, solid lubricants may be described as low-shear-strength solid materials. Their function within a bronze bearing is to act as an intermediary material between sliding surfaces. Since these solids have very low shear strength, they shear more readily than the bearing material and thereby allow relative motion. While solid lubricant remains between the moving sur-

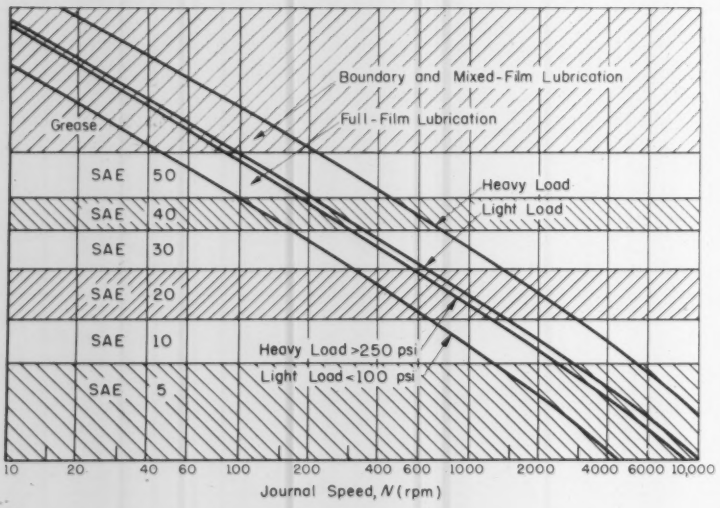


Fig. 31—General guide to lubricant selection for cast-bronze sleeve bearings operating between 60 and 140 F. (After B. Dunham)

faces, effective lubrication is provided, and friction and wear are reduced to acceptable levels.

Two common solid lubricants currently used to provide effective lubrication of bronze bearings are listed in Table 7. Where high temperatures prevail, or where oil or grease contamination cannot be tolerated, solid lubricants are specified. Normal cast-bronze sleeve-bearing materials are not recommended above 550 F, but special bearing bronze alloys containing graphite plugs are available for temperatures up to 1000 F.

Graphite, in addition to its desirable high-temperature properties, will not react with bearing or journal materials. Mixed with oil or grease, graphite improves their boundary lubricating properties. Also, metal surfaces coated with graphite are more readily wetted with oil or grease. Because dry graphite is difficult to apply, surfaces are usually coated with a solution of graphite in a volatile carrier or vehicle. After vaporizing, the vehicle leaves a thin film of graphite on the surfaces.

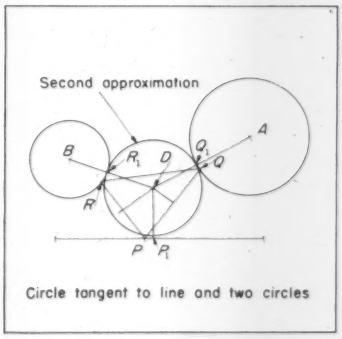
Molybdenum disulfide has an affinity for metal. When rubbed on a metal surface, it forms a thin, durable film of solid lubricant. Correctly applied, it provides good protection against galling and seizing over a wide temperature range. Molybdenum disulfide has good extreme-pressure characteristics and can be combined with oils and greases to enhance their boundary lubricating qualities. It is also available in spray or paste form for more convenient application.

Next article in this co-ordinated program will discuss general requirements of sleeve-bearing materials. Characteristics and uses of the most popular cast bronzes will be covered in detail.

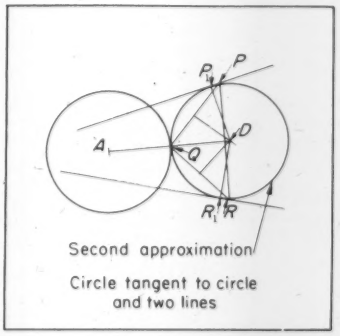
Tips and Techniques

Tangent Circles

To find a circle tangent to a straight line and two other circles, select three points P, Q, and R on the line, and on the circles. Find the center D of the circle which circumscribes P, Q, R. Join D to A and B to obtain Q_1 and R_1. Find P_1 by a perpendicular from D. P_1, Q_1, and R_1 now form a second approximation of points on the desired circle. Successive approximations are taken until the desired accuracy is reached.



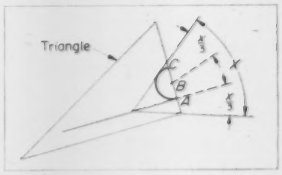
Circle tangent to line and two circles



Circle tangent to circle and two lines

To find a circle tangent to a circle and two straight lines, again choose P, Q, and R. Successive approximations are obtained in the same manner as before. —C. G. Ray, *Indian Institute of Technology, Kharagpur, India.*

Trisecting Angles



A useful figure to have scribed on a triangle is a tomahawk for the trisection of angles. Along one edge of the right angle, scribe three equal segments, beginning at this corner from the first (Point A) scribe a line perpendicular to that edge. From the second (Point B) with AB as a radius scribe a semicircle. In use, the handle (the perendicular line) is placed over the vertex of the angle to be trisected. The right angle corner is then placed on one leg and the semicircle brought tangent to the other leg of the angle. Points A and B now form the trisectors.—Jesse Roth, *New York, N. Y.*

Basic steps in developing

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Steps in Magnesium Casting Design

New Design

1. Determine the theoretical loading of the part.
2. Match these loads against known metal strength to establish initial design configuration.
3. Create the prototype casting.
4. Perform the necessary experimental stress analysis.
5. Match results of stress analysis against known materials data to establish final design.
6. Test final design to determine whether further changes are required.

Substitute Design

1. Assume that the design in the former metal is adequate.
2. Revise the design to allow for structural inadequacies and for changes in fabrication procedures.
3. Match sections of previous metal with proposed light metal and consider property data for each to establish initial design configurations.
4. Make initial casting.
5. Perform experimental stress analysis to determine suitability of design.
6. Compare results against known property data to help establish final design.
7. Make necessary revisions and proof test the final configurations.

WHEN light-alloy castings are required for an application, designers can approach the problem in one of two ways. They can start with a completely new design, or they can start on the basis of a previous design in another metal for which the light-alloy casting is to be substituted.

New Designs: Structural uses for which the designer must develop a new design frequently involve complex design requirements where loading and other factors defy predictability. In such cases, a prototype casting is made based on matching theoretical loading requirements against the known safe static, fatigue, impact, and creep-strength property values given for the metal.

At this point, two problems must be considered. The first is the method for accurately predicting service loading requirements. The accuracy of theoretical design analysis for predicting service conditions in castings where complicated load-

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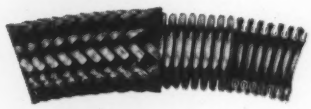
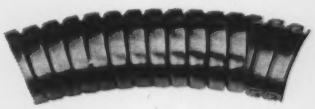


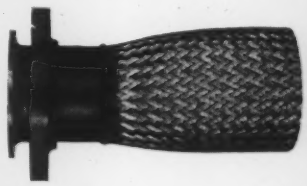
Seamless: Of tin bronze (98¾% copper, 1¼% tin)—also corrugated stainless steel—in sizes ⅛" through 4" I.D. For conveying fluids, chemicals, etc., under conditions of flexure or vibration and to allow for misalignment. Reusable (mechanical type), soldered or welded fittings.



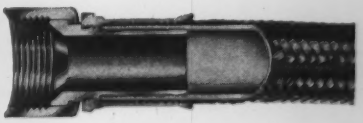
Stripwound: Constructed from brass, bronze, aluminum, galvanized or stainless steel. Sizes ½" through 8" I.D. A rugged type of hose for general service as steam, oil, water, particularly where the hose is handled manually. Fittings: soldered or heatproof (packed-on).

Type UI: Interlocked unpacked hose in galvanized steel, stainless steel, aluminum, etc. Sizes through 8" I.D. For ventilating ducts, dust collection, engine exhausts, exhausts at grinding machines, bottle chutes, drain lines, protective casing for flexible hose assemblies.

Diesel: Heavy-duty steel exhaust and air intake hose. Sizes 2" through 16" I.D. Designed for rugged, heavy-duty use. Helical corrugations with open or closed pitch. Also in stainless steel (type Y-21) for corrosive applications.



Flexpipe: Takes up travel in piping, connects misaligned ports, dampens noise and vibration in piping. Standard sizes and lengths. Available in bronze, stainless steel, steel; in sizes ¼" through 16" I.D. with NPT fittings, flanges or welding nipples.



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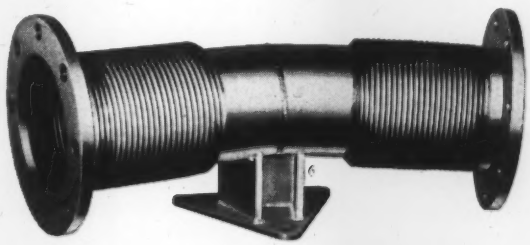

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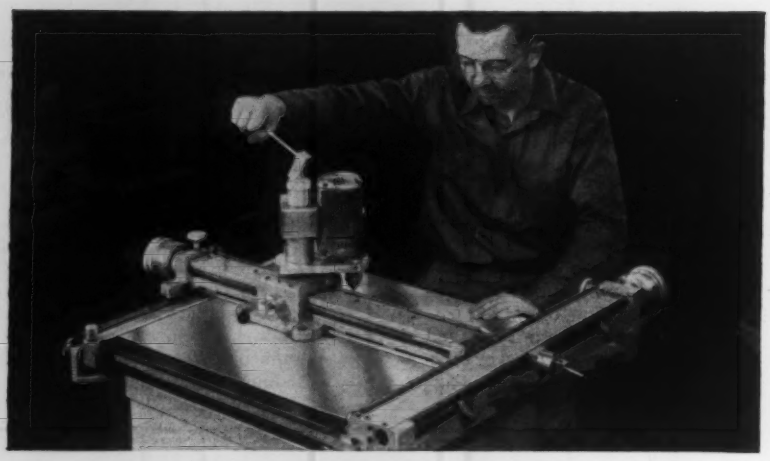

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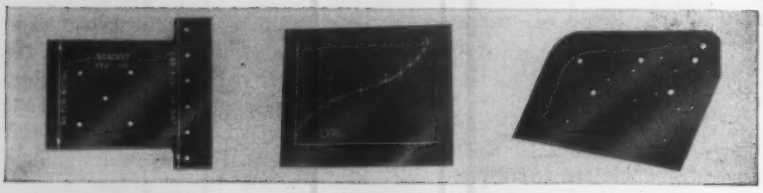

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ing is involved is inadequate. Such calculations usually must be predicted on a simple static-loading and do not properly consider complex dynamic loading, fatigue, and impact problems that may be critical. Consequently, theoretical calculations serve only as a starting point.

The second problem involves predicting serviceability from available mechanical-property data. The only data that can be used are those which can be interpreted, to the proper degree, in terms of the foundry and other practical variables that are likely to be present.

These variables include effects of porosity, grain size, perfection of heat treatment, surface smoothness, and stress concentration. If data are available, and experience has been obtained to demonstrate how the data can be used directly for design purposes, the first design can now be established.

Substitution Design: It is often advisable, when changing materials, to develop a new design from "scratch," thereby permitting freedom for attacking the problem as a whole. In some cases, however, when materials are being changed to magnesium or aluminum, it is imperative that the starting point for designing be the design in the metal previously employed.

If, over a period of service, the part in the previous metal was a success, the problem is simplified for the designer. The usefulness of complete strength data again becomes apparent.

In this case, the designer may substitute magnesium or aluminum, and take into consideration respective strength properties of the previous and proposed new metal. Essential for this procedure is complete strength information for the previously used material. This, however, is frequently not complete. Therefore, another problem is posed in simple substitution techniques.

If the part to be converted to light alloys was not adequately designed, alterations can be planned based on the previous service information on the part. Frequently, certain features of the previous design are necessary to enable given fabrication methods to be employed. Such would be the case where

pressed or formed-steel parts are involved.

When a casting is designed to replace a formed and assembled part, sections should be changed to accommodate the casting process. Certain section thicknesses and design details incorporated in the previous design may have been necessary to facilitate forming and should be identified and altered to favor the casting process and structural efficiency requirements.

After the initial design is established, a prototype casting should be made. Efficiency of this first design is then evaluated by experimental stress checks. Strength data, if available and sufficiently extensive, are again used for comparison with stresses measured in the experimental stress analysis.

On the basis of this comparison, a new, and perhaps final, casting design can then be made.

Casting Configurations: Magnesium may be used in many applications on an equal-volume basis, with a full weight saving in proportion to relative density. If a small amount of magnesium is added to the general wall thickness of a previous heavy-metal design, ribbing can usually be eliminated.

The resulting magnesium structure is only slightly heavier than the ultimate weight savings offered by magnesium on equal-volume basis substitutions. Thus, rigidity and strength of the increased thickness become quite adequate for most applications without the complications of rigidizing ribs and other complicated stress raisers. Many designers conclude that ribs do not materially strengthen castings. Such ribbing systems provide stress-concentration zones, poor-quality zones, and crack-propagation centers, especially in dynamically loaded parts.

Most magnesium sand castings are sufficiently massive after the above treatment that the lower modulus of elasticity of magnesium becomes a much reduced problem. Avoidance of stress concentration by addition of wall thickness rather than ribs is in accordance with recommended practices for generous filleting.

The lower modulus of elasticity of magnesium alloys may contribute

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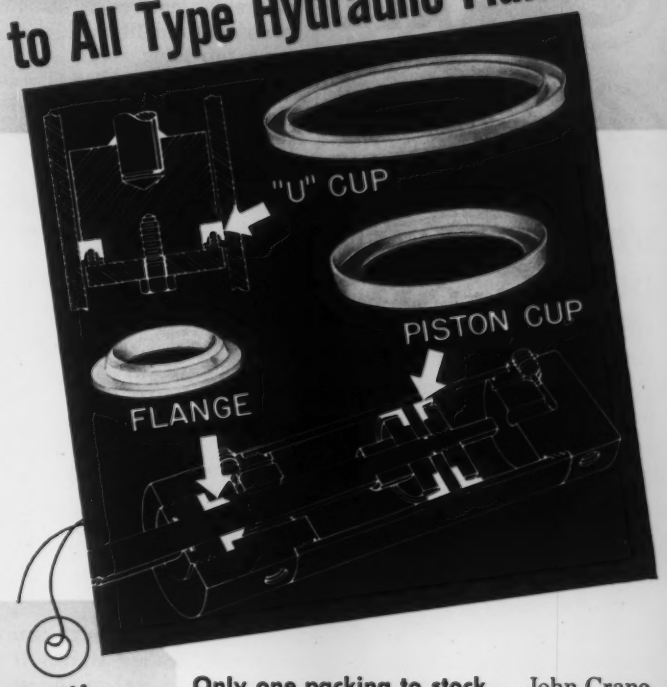

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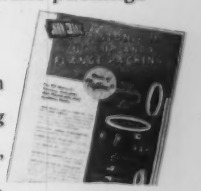

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Circle 489 on Page 19

to better serviceability since it effects an improved distribution of loads in the principal carrying members. One of magnesium's most favorable features is its high dimensional stability at high temperatures providing recommended heat treatments are applied.

The coefficient of thermal expansion of magnesium is somewhat higher than for the heavier structural metals. This should be taken into account to avoid development of high stresses which could lead to creep and distortion.

AFS Paper, American Foundrymen's Society Castings Congress, Chicago, 1959; 6 *pp.*

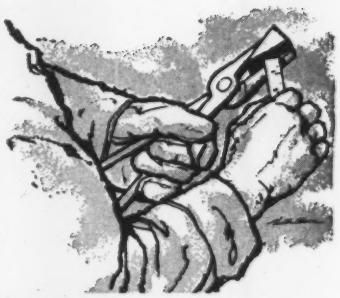
High Temperature Hydraulic-Pump Seals

A. B. BILLET, Vickers Inc.

ONE of the major areas of development in high-temperature hydraulic sealing studies is that of the dynamic seal of the unit drive shaft. Tests indicate that Viton A in a conventional lip-type radial shaft seal is the best possibility at temperatures to 400 F. Under these conditions, a life of approximately 100 hr is achieved. This type of seal will work on a shorter life basis at temperatures to 550 F. Above this temperature, the lip-type seal does not appear to be practical since elastomeric life is based on time and temperature, and increasing temperatures decrease life to a marked degree.

Considerable work has also been conducted on lip-type seals using various percentages of a glass-Teflon filler. Experience indicates that when a satisfactory seal is effected, excellent results are achieved. However, seals give extremely nonreproducible results.

One type of seal utilizes a carbon-rubber surface in conjunction with a Viton A static O-ring. This latter seal is the limiting-temperature factor in such a configuration. These seals are somewhat difficult to utilize in production due to special handling required, and they occupy ½ to ¾ in. more space than con-



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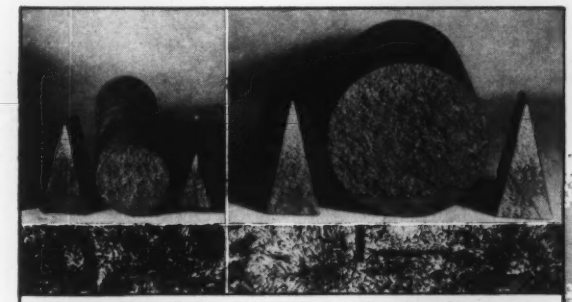

This photograph shows control of uniformity of structure with increasing casting thickness. Note that the microstructure is the same in both small and large sections.

During the melting of Meehanite metal, carbide structure tests are made before and after processing to insure complete control of micro structure, density and physical properties in the finished casting.

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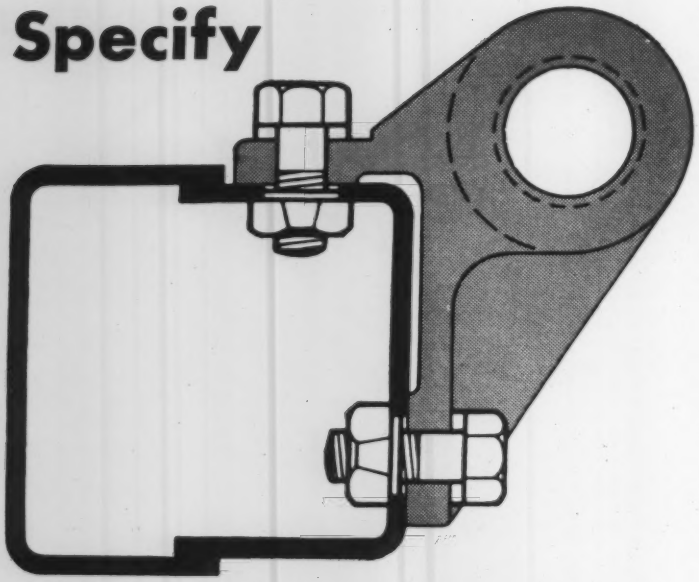

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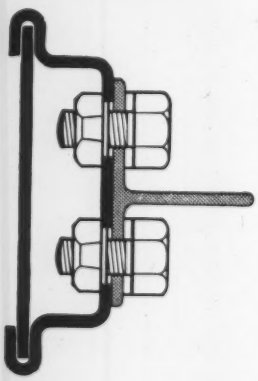

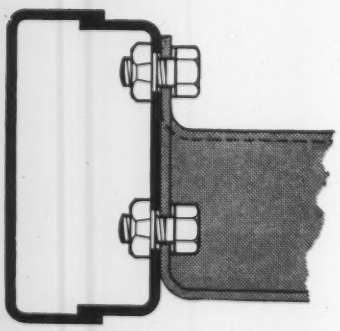

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ventional lip types. The type of material used to impregnate the carbon must be compatible with the fluid in the circuit. In some cases, synthetic hydraulic fluid dissolves this solution, resulting in the passage of fluid through the carbon.

In addition to the development of a face-type carbon seal, an all-metal convolute-bellows seal has been successfully used at temperatures approximating 500 F. An important feature of this seal is a stainless-steel bellows which provides spring force necessary to hold a pump stator against the rotor. This bellows eliminates secondary leakage paths which have been a major problem in face-type seals and also provides a floating stator face which can take axial motions and minor misalignments inherent in these arrangements. This seal configuration still takes more space in the pump than either of the other two types of seals.

Static-Seal Development: Seals of silicone and Viton A appear to give the best sealing characteristics in the 400 to 550 F temperature range. One of the present difficulties with elastomeric seals is compression set at high temperatures with failure to reseal for subsequent thermal cycles. For temperatures above 500 F, elastomeric seals have been replaced with loaded-Teflon or metal O-rings.

Metal seals show excellent characteristics of life and retention of dimensions at high temperatures but are somewhat difficult to use. Tolerances must be maintained to a much closer limit than in the elastomeric seals, and the metal seals are less tolerant of surface finish defects and misalignments.

One of the factors that has to be given special consideration in design for a satisfactory static seal at high temperatures, is the coefficient of expansion of mating pump parts near the seal which may affect clearances.

Fluid Compatibility: Sealing problems are further increased due to some properties of the various new high-temperature synthetic fluids. The standard MIL-H-5606 fluid is now used at temperatures to 275 F. The OS45 and MIL-L-7808

types of fluids are used at temperatures from 300 to 450 F. The Oronite type fluids are used at temperatures in the 500 to 600 F range. Silicone-type fluids, such as Versilube, are being developed for the 600 to 700 F range.

Seals for Hot-Gas Servo Systems: In certain missile applications, control systems use a hot gas as the fluid medium in place of hydraulic fluid. Nitroglycerine and nitrocellulose produce gas temperatures from 700 to 3600 F. In this type of equipment, sealing problems are of a vastly different nature. Leakage of a hot gas by the seal results in rapid heating of adjacent parts. Since the fluid has no lubricity, sliding metal surfaces must be minimized to reduce wear and friction.

Probably the worst result of a hot-gas seal leak is dissipation or complete loss of power in the generating system. A satisfactory seal is mandatory. Total operating time on present hot-gas systems varies from 30 sec to 30 min.

In short-run hot-gas systems of the 30 to 120-sec "single-shot" category, elastomeric seals can be used. For multiple-shot seals, or extended running, metallic seals are a necessity. In the rotating seal, a face-type carbon seal is required.

SAE paper 50T, SAE National Aeronautic Meeting, New York, 1959; 5 *pp.*

Refractory Nonmetals At High Temperature

JOHN M. NOWAK, Bell Aircraft Corp.

BRITTLENESS is the major drawback in using ceramic materials as structural hardware. Although the materials are usually poor in tensile strength at room temperature, compressive strength is generally excellent. Many ceramic materials, however, have better tensile strengths than metals at temperatures of 1800 F and above. A short-time tensile of about 22,500 psi at 1800 F for a boron-carbide body has been reported. Designs using a ceramic material should take into account the relatively

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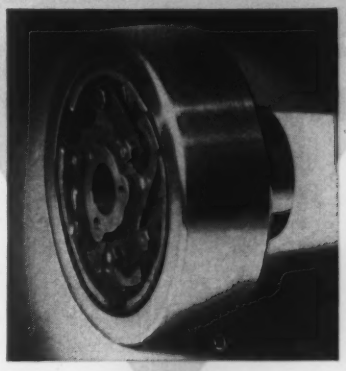

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smooth starting with protection against overload shock.

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in all directions without any loose joints.

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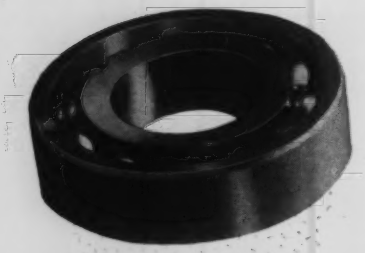

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Circle 492 on Page 19

high tensile strengths of some of these materials at elevated temperatures. Studies are now under way to improve ductility of ceramics.

Alumina can be considered competitive with molybdenum in the temperature range of about 2000 F, based on ultimate strength-density ratio. Metals for use at temperatures of 2000 F and higher are subject to oxidation. Other factors which must be considered are effect of brittleness of alumina on design application, creep rupture strength, effect of oxidation on molybdenum, and effect of coatings on the strength of molybdenum. However, possibilities do exist for ceramics as structural materials at relatively low temperatures of 2000 F.

Refractories for Hot-Spot Areas: Most of the high melting-point materials have mechanical, thermal, or chemical properties which make them unsuitable for some applications where temperatures exceed 2500 F and approach 4000 F. Oxides as a class appear to have lower useful operating temperatures than the carbides. They tend to have lower strength at high temperatures. Some are subject to thermal shock. The carbides, however, generally have higher melting points, higher strengths at elevated temperatures, and are not subject to the degree of thermal shock that is common to some oxides. At sufficiently elevated temperatures, carbides will oxidize.

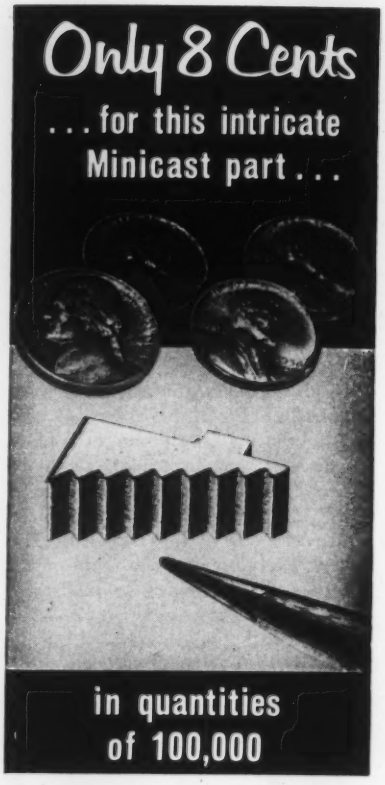
Of carbide materials tested, the best oxidation resistance at 2800 F is exhibited by a refractory body consisting of 90 per cent silicon carbide and 10 per cent boron carbide.

SAE paper 56S, SAE National Aeronautic Meeting, New York, 1959; 5 *pp.*

TO OBTAIN COPIES of papers or articles abstracted here, write directly to the following organizations:

AFS — American Foundrymen's Society, Golf and Wolf Rds., Des Plaines, Ill.

SAE — Society of Automotive Engineers Inc., 485 Lexington Ave., New York 17, N. Y.; papers 50 cents to members, 75 cents to nonmembers.



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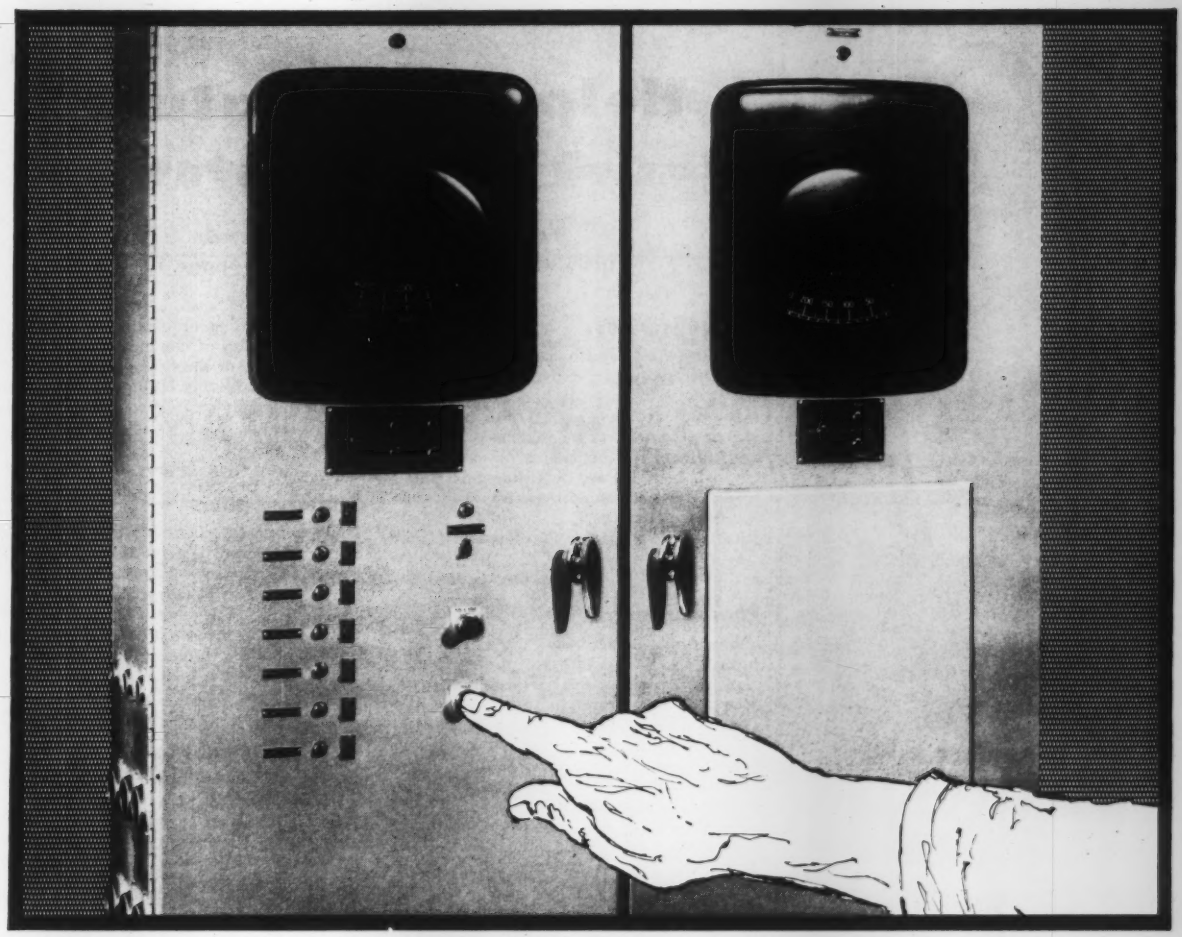

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May we have the opportunity of submitting our quotation or proposal covering your requirements. There is no obligation, of course.

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Lists Pantro uses and Pantro users. Shows a cross-section of the many types of automatic control panels Pantro has designed or built for industry of all kinds.

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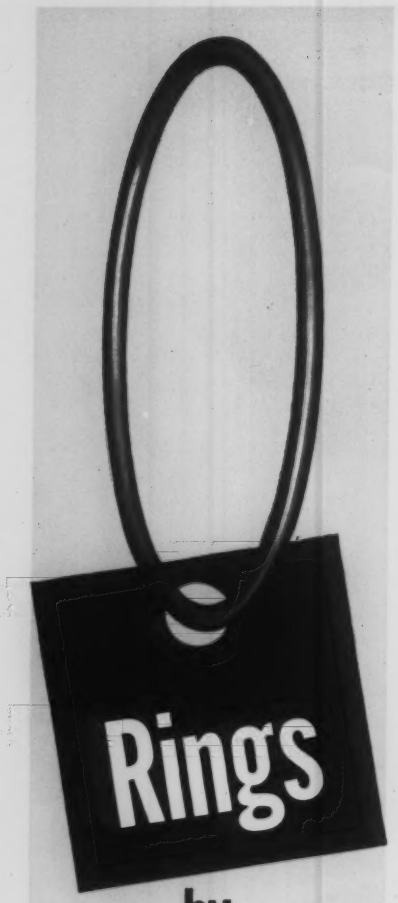
- Printing trades machinery
- Power processes
- Rubber working machinery
- Special industry processes and machinery
- Textile machinery
- Woodworking machinery
- Conveying equipment
- Cranes, hoists, derricks
- Furnaces and ovens
- Hydraulic equipment
- Internal combustion engines
- Packaging and labelling machinery
- Railroad equipment
- Communications equipment
- Electronics equipment
- Motors, generators, motor generator sets
- Nuclear processes



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Helpful Literature for Design Engineers

For copies of any literature listed, circle Item Number on Yellow Card—page 19

Hydraulic Valves

Pressure controlled hydraulic valves used for relief, sequence, reducing, unloading, and counterbalance in hydraulic circuits involving pressures to 3000 psi are subject of Engineering Manual 230. All factors influencing the choice of valves are covered. Included are flow diagrams, pressure vs. flow curves, ratings, drawings, and specifications of various types. 20 pages. Rivett, Inc., Brighton 35, Boston, Mass. B

Circle 601 on Page 19

Phosphor Bronze

Illustrated Handbook on phosphor bronze wire, bars, rods, strip, sheets, circles, and special shapes also contains information on Flexograin fine grain phosphor bronze and on company's facilities for the continuous casting of phosphor bronze strip. Properties, application guidance, available forms, and other data are included. 20 pages. H. K. Porter Co., Riverside-Alloy Metal Div., Riverside, N. J. E

Circle 602 on Page 19

Hydraulic Pumps

Design, performance, and other features of the PR-200 variable-delivery radial piston pump which delivers up to 200 gpm at 3000 psi are explained in illustrated bulletin. Performance curves show efficiency, input, output, and other data. 4 pages. Texas Hydraulics, Inc., 8500 Research Blvd., Austin 5, Texas. P

Circle 603 on Page 19

Frequency Detector

The Megmeter is a frequency detector which delivers a direct current output voltage proportional to the input frequency. It measures frequencies to 10,000 cps at a linearity better than 0.25 per cent. Details are given in Bulletin F-25. 4 pages. Airpax Electronics Inc., Seminole Div., Fort Lauderdale, Fla. O

Circle 604 on Page 19

Centrifugal Pumps

Bronze and iron centrifugal pumps with capacities up to 320 gpm and pressures to 40 psi are covered as to their design, performance, and application in Bulletin 1004. Belt and direct drive types are available in 22 models and four sizes for ¾ to 2-in. pipe. 6 pages. Marine Products Co., 609 Lycaste, Detroit 14, Mich. H

Circle 605 on Page 19

Combustion Safeguard

Usable on heating and heat treating applications, the Protectifier combustion safeguard control provides continuous protection against fires or explosions resulting from a build-up of combustible fuel mixtures in single or multiple burner installations. Details of this UL-approved system are given in Bulletin 659. 4 pages. Protection Controls, Inc., 600 N. Legett Ave., Chicago 46, Ill. I

Circle 606 on Page 19

Sanitary Casters

Developed especially for the food handling and processing industries, Sanitary casters described in Catalog 59-A are completely sealed and meet the Industry Sanitation Code. They are available with 4 to 6-in. Texite wheels and have load ratings up to 1200 lb. Stationary and swivel types are offered. 4 pages. Albion Industries, Inc., Albion, Mich. H

Circle 607 on Page 19

Materials Evaluation

Extensive facilities and services for the analysis, development, research, and inspection of materials and products offered to industry by this company are described in Bulletin 5902. Among the services are metallurgical studies, metals chemistry, plastics evaluation, and physical testing. 6 pages. United States Testing Co., 1415 Park Ave., Hoboken, N. J. D

Circle 608 on Page 19

4-Way Air Valves

Bulletin 235 is descriptive of alternate bases and integral speed control sections for Series CC 4-way directional air valves. These accessories simplify piping layouts, meet JIC recommendations, and are usable for a range of pneumatic control systems. 4 pages. Hannifin Co., 501 S. Wolf Rd., Des Plaines, Ill. J

Circle 609 on Page 19

Rubber Coated Fabrics

Typical properties of stocked silicone rubber-coated fabrics are tabulated in data sheet. Cohrlastic products shown are used for thin gasketing, diaphragms, seals, tapes, ducting, insulation, belting, and protective covering. 2 pages. Connecticut Hard Rubber Co., 407 East St., New Haven 9, Conn. B

Circle 610 on Page 19

Temperature Controls

Two temperature controls, the 3ART-5 for domestic and commercial refrigeration systems and the 3ART-15 for room air conditioners, are detailed on Data Sheet GEA-6972. Dimensions and ratings are presented. 2 pages. General Electric Co., Schenectady 5, N. Y. C

Circle 611 on Page 19

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One in a series of technical reports by Bower

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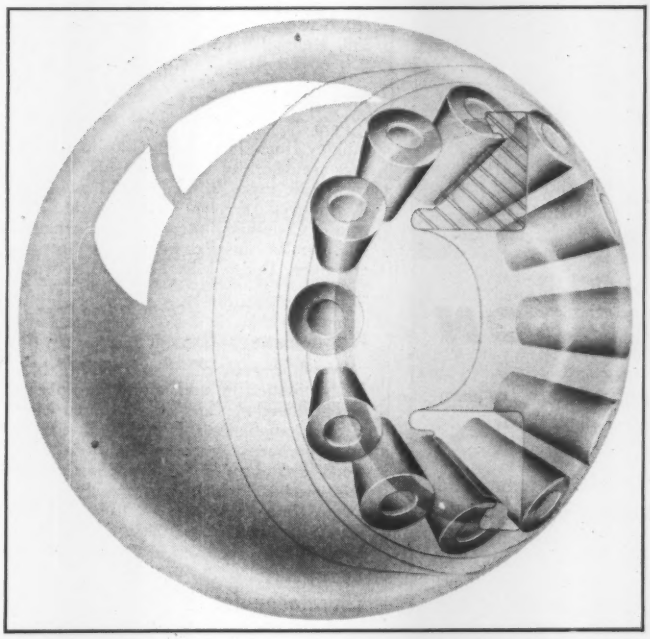
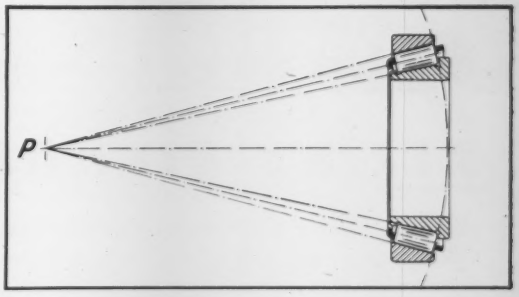


When you require bearings, we suggest you consider the advantages of Bower bearings. Where product design calls for tapered or cylindrical roller bearings or journal roller assemblies, Bower can provide them in a full range of types and sizes. Bower engineers are always available, should you desire assistance or advice on bearing applications.



True rolling of tapered bearing elements depends upon maintaining a true spherical radius during manufacture.

For a tapered roller bearing to achieve maximum performance, i.e., maximum life and capacity under load, it must have true sphericity — a condition of bearing geometry which permits true rolling of the tapered rollers in the raceway.

True rolling in tapered bearing elements is the result of maintaining a critical geometric relationship between the raceways and the contact surfaces of each roller. True rolling is essential to maximum performance. Without it, premature bearing failure is certain.

As engineers know, a tapered roller will describe a true circle when rolled on a plane surface. *It will always roll in this one path precisely, without sliding or skewing.* But to put true rolling to work in a bearing which can carry both heavy thrust and radial loads, it is essential that the rollers *and* the raceway have a true spherical radius, or sphericity. The drawing illustrates this condition.

If each roller in the bearing were to be extended in length, while retaining its taper, it would form a cone, terminating at point "P". All cones generated from all rollers would meet at point "P", which is also the center of the hypothetical sphere shown. The surface of the sphere would *touch all points on each roller's head!*

In effect, then, each roller's taper determines the radius of a hypothetical sphere whose surface, in turn, determines the correct contour for each roller head. Only when these conditions are satisfied in design, and when they are rigidly held during manufacture, will true rolling take place. In the manufacture of each Bower tapered roller bearing, sphericity is held within extremely narrow limits by means of special Bower-designed precision grinders. The consistent accuracy possible with these machines is one major reason why Bower roller bearings provide maximum performance under all speeds and loads up to the bearing's maximum rating.

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Circle 496 on Page 19

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For many years The Richardson Company has served industry as a skilled fabricator of high quality, uniform laminated plastic parts . . . produced to exacting customer specifications.

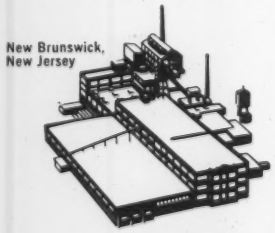
As the manufacturer of INSUROK® laminated sheets, tubes and rods, Richardson guarantees the finest fabricating materials in a wide range of NEMA, Federal and Special Grades.

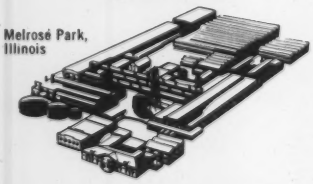
Fabrication dies and tools are designed and produced right in Richardson plants. Therefore, they are properly engineered for the material and will produce quality parts.

Two Richardson plants located in New Brunswick, New Jersey and Melrose Park, Illinois offer complete fabrication facilities for all forms of laminated plastics. This assures you prompt shipment of finished parts.

From ONE RELIABLE SOURCE you obtain quality materials, tooling, and fabricated parts.

To get more details on how Richardson's integrated fabrication facilities can serve you, write to The Richardson Company.





the RICHARDSON COMPANY

LAMINATED AND MOLDED PLASTICS — Founded 1858

DEPT. 42, 2795 LAKE ST. • MELROSE PARK, ILL. • SALES OFFICES IN PRINCIPAL CITIES

HELPFUL LITERATURE

Plastics

Revised Bulletin D400 contains general data on properties and uses of thermosetting phenolic and diallyl pthalate molding compounds, fire retardant Hetron polyester resins, and phenolic resins for bonding and coating. Application data are included. 8 pages. Hooker Chemical Corp., Durez Plastics Div., 8 Walck Rd., North Tonawanda, N. Y. N

Circle 612 on Page 19

Time Delay Relays

Electronic time delay relays incorporating a transistor timing module with no moving parts are subject of Bulletin 5903. Standard units are built for 28-v dc, with double-pole double-throw or three-pole double-throw balanced armature output relays with 10-amp resistive ratings. Delay times available are from 0.020 to 300 sec. 8 pages. Tempo Instrument Inc., Box 338, Hicksville, N. Y. D

Circle 613 on Page 19

Flexible Couplings

Para-flex flexible cushion couplings ranging from fractional to 190 hp per 100 rpm are described in Bulletin A669C. Two new sizes make a total of 12 available. The largest delivers 2000 hp at 1080 rpm. Couplings accommodate angular and parallel misalignment. Specifications are given. Dodge Mfg. Corp., Mishawaka, Ind. J

Circle 614 on Page 19

Wood Veneer Uses

Wood veneers, sliced to 1/85-in. thick, for lamination to steel, aluminum, plastic, and Fiberglas, are incorporated into kitchen appliances, lamps, and various other products. Brochure "Industrial Flexwood" shows a number of applications for the product which can be bent and formed once laminated. 8 pages. United States Plywood Corp., 2921 S. Floyd St., Louisville 17, Ky. G

Circle 615 on Page 19

Thermocouples

Thermocouples, their components and accessories are described in detail in Catalog EN-S2. Standard assemblies in protecting tubes and wells for general use, and special units for laboratory and industrial use are covered, along with wires, replacement elements, ceramic insulators, wells, terminal heads, and extension leadwires. 52 pages. Leeds & Northrup Co., Philadelphia 44, Pa. E

Circle 616 on Page 19

Air Control Valves

Line of hand, foot, air, and solenoid actuated air control valves is described in two illustrated bulletins. Disc type valves from $\frac{1}{4}$ to 1-in. pipe size and pilot operated $\frac{1}{4}$ to $\frac{3}{4}$-in. valves for two, three, and four-way operation are subject of Bulletin 8100. Bulletin 8101 describes Designer $\frac{1}{8}$ to $\frac{1}{2}$-in. valves for direct actuation of small cylinders and for use as pilot valves in sequence circuits. 4 pages each. Cleveland Pneumatic Industries, 64 Old Orchard, Skokie, Ill. I

Circle 617 on Page 19

Adjustable Speed Drives

Performance and application data on line of electric adjustable speed V-S Jr. drives from 1/8 to 4 hp are found in illustrated Bulletin D-2507. Condensed specifications and a gearmotor selection table are included. 12 pages. Reliance Electric & Engineering Co., 24701 Euclid Ave., Cleveland 17, Ohio. G

Circle 618 on Page 19

Motor HP Nomogram

Nomogram for horsepower, torque, and rpm is applicable to fractional horsepower motors and transmissions. It has two scales each for torque and horsepower. Rpm scale is from 0.5 to 500 rpm and torque to 300 and 600 lb-in. 1 page. Merkle-Korff Gear Co., 213 N. Morgan, Chicago 7, Ill. J

Circle 619 on Page 19

Servo Components

Control and torque synchros and resolvers are described in detail and their specifications are contained in an illustrated brochure. Information about the newly-formed company and its personnel is also included. Vernitron Corp., 136 Church St., New York 7, N. Y. D

Circle 620 on Page 19

Heavy Duty Counters

Heavy duty counters for indication, recording, and automatic regulation of material flow are described and illustrated in Bulletin 0159. Models for use in receiving, process and inventory control, and shipping are discussed, as are ticket printing components and impulsing switches. 4 pages. Richardson Scale Co., Clifton, N. J. D

Circle 621 on Page 19

Drafting Machine

Improved Model 70 drafting machine offers instant interchangeability with other units of the same size or for use on other boards, according to illustrated Bulletin M70. Detailed specifications and photos of design features are included. 4 pages. Glideline Corp., 300 S. Potomac St., Waynesboro, Pa. E

Circle 622 on Page 19

Tube & Bar Stock

Comprehensive physical properties chart found in Bulletin 156 serves as an application guided for GC Meehanite metal, GA Meehanite metal, and Type No. 1 Ni-Resist bar and tube stock. Typical uses are illustrated. 6 pages. Shenango Furnace Co., Centrifugally Cast Products Div., Dover, Ohio. G

Circle 623 on Page 19

Magnetic Starter

Catalog 14-Bl is descriptive of the new Furnas magnetic starter. Rated through 15 hp at 440-550 v, it features front removable components, dual voltage coils that are reconnectable on the job, and trip-free thermal overload relays with trip indicators. 16 pages. Furnas Electric Co., 1045 McKee St., Batavia, Ill. I

Circle 624 on Page 19

"MADE BY ENGINEERS FOR ENGINEERS"

to
YOUR
specifications

Rugged Individuals

by CORNISH

FOR 40 YEARS we've built Blue Chip cord sets, tailored to the particular needs of America's top electrical manufacturers. Let CORNISH *Rugged Individuals* enhance the performance of your equipment and the prestige of your name . . . despite heat or cold, shock or vibration, ozone or chemical hazards . . . in rubber, neoprene or plastic . . . in decor colors if specified.

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Support your local ADEQUATE WIRING BUREAU Program . . .

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Producers of Quality Wire Products for Home, Farm and Industry

Circle 498 on Page 19

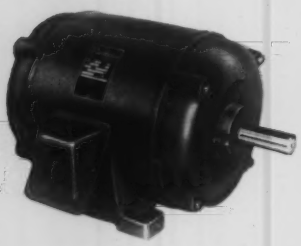
PEERLESS SPECIAL AND STANDARD ELECTRIC MOTORS

Peerless specializes in customer-manufacturer teamwork engineering of special motors. Unusual operating conditions and duty requirements are everyday problems to us. We are the exclusive motor supplier to many original equipment manufacturers. Our knowledge works to your advantage in reducing the engineering time required to solve your motor problem.

TYPES and RATINGS

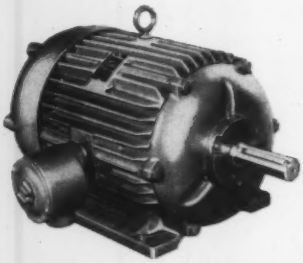
Single Phase	½ thru 10 HP
Polyphase	½ thru 30 HP
Direct Current	¼ thru 3 HP
TEFC (single phase)	1 thru 10 HP
TEFC (polyphase)	1 thru 30 HP
Explosion-Proof	Same as TEFC
Torque	2 oz. in. to 200#ft.

Special Designs to Specifications



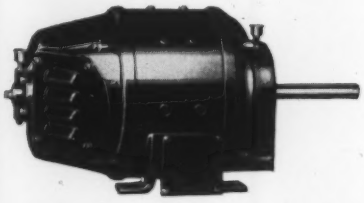
DRIP-PROOF (open type)

Completely protected against dripping liquids and falling particles. Surfaces are smooth and symmetrical. Frame sizes from 56 to 324 as shown. Frames 324 and 326 have welded frame. Cast-iron construction. Sleeve or ball bearings.



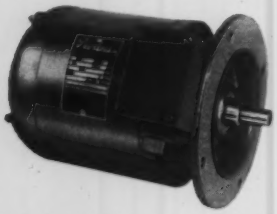
TEFC and EXPLOSION-PROOF

External fan draws cool air across motor toward driven machine. Heat from machine is not drawn across motor. Explosion-proof designs approved for Class I and II duty. Special mounting designed to meet application requirements. For HP ratings see table above.

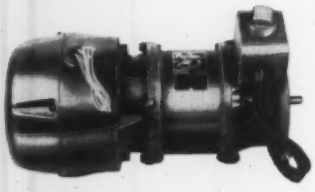


DIRECT CURRENT

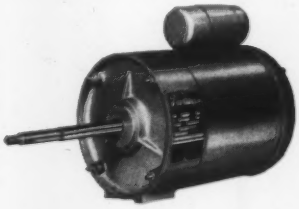
Designed for rough usage. High starting torque, good overload capacity and high electrical efficiency. Shunt, series or compound windings. Constant speed generators in ratings from 150 to 3000 watts. See HP ratings above.



WEATHER-TIGHT SPECIAL FLANGE



EXPLOSION-PROOF TORQUE MOTOR WITH BRAKE



SPECIAL FLANGE REVERSING HOIST MOTOR, SINGLE PHASE

ENGINEERING DATA—These bulletins are available from Peerless: Space-Saver, SP-1; Torque, T-1; and SDA-155 describing the complete line. Peerless builds many special mountings. Various modifications—special shaft features; paint and varnish treatments; Class A, B, F, H insulation, etc. are available. Peerless builds to the standards and specifications of JIC, AIEE (including AIEE No. 45 Marine Duty), ABS, Federal and Military.

ELECTRIC MOTOR DIVISION

THE *Peerless Electric*® COMPANY

FANS · BLOWERS · MOTORS

1520 W. MARKET ST. · WARREN, OHIO

Circle 499 on Page 19

Rubber Parts

Molded and extruded rubber parts for automobile, aircraft, machine, appliance, office equipment, and railroad use are described in six sections of Bulletin AD-167. Aid in choosing the right material is provided in tabular form. Properties of various rubbers are given. 6 pages. Garlock Packing Co., 436 Main St., Palmyra, N. Y. N

Circle 625 on Page 19

Heat Control Valve

Temperatures from 35 to 450° F are controlled with only 10 ranges by a pilot-operated temperature control valve, subject of Data Sheet JNP-2. It has a sliding gate and plate main valve. Design features, specifications, and prices are given for 2½ and 3-in. sizes. 2 pages. OPW-Jordan, 6013 Wiehe Rd., Cincinnati 13, Ohio. G

Circle 626 on Page 19

Circuit Breakers

Details of the new 2300 Series circuit breaker are given in illustrated bulletin. This 2½-oz control has pushbutton action, is shock resistant and precision calibrated, and will protect circuits up to 5000 amp on 120-v 60-cycle ac. 8 pages. Wood Electric Co., 244 Broad St., Lynn, Mass. B

Circle 627 on Page 19

Air Filter-Regulators

Combination air filters, regulators, and lubricators for compressed air service in up to 2-in. sizes, and for various pressure ranges to 250 psi are described in Circular 1014. Units can be used individually or in any combination. 2 pages. Wilkerson Corp., 1646 W. Girard, Englewood, Colo. K

Circle 628 on Page 19

Dry Film Lubricants

Pocket-size "Design Handbook" is devoted to the advantages, applications, and properties of dry film lubricants. Where and how to use these coatings are explained, and design considerations are covered. 20 pages. EverLube Corp., 6940 Farmdale Ave., N. Hollywood, Calif. L

Circle 629 on Page 19

Powdered Metal Parts

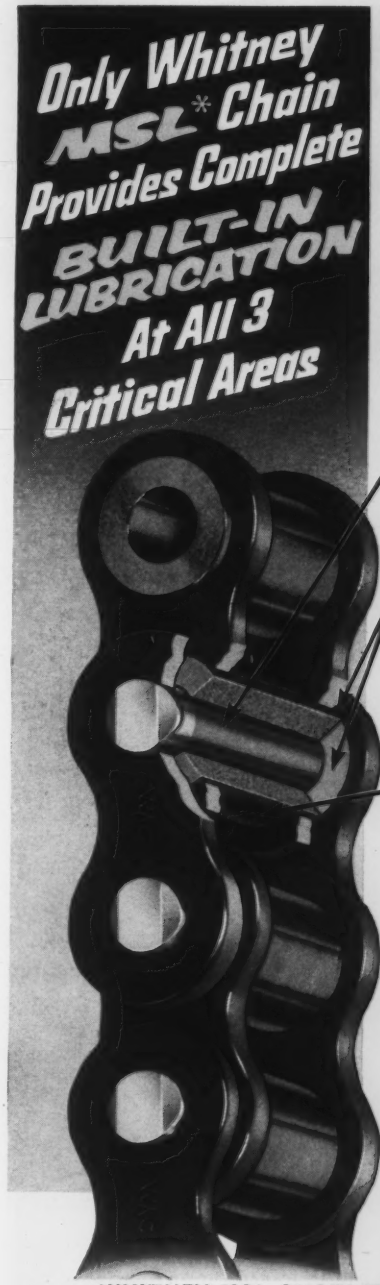
Self-lubricating bearings, soft iron magnetic parts, porous metal filters, and machine parts are among the products made of powdered metals shown in illustrated bulletin. Design potentials of these parts are explained. 4 pages. Asco Sintering Corp., 7799 Telegraph Rd., Los Angeles 22, Calif. L

Circle 630 on Page 19

Creating New Vinyls

"Creating New Vinyl Products for Industry" is title of brochure which briefly discusses and illustrates company's engineering and design, die making, compounding, process control, and extrusion facilities for making industrial vinyl products. 16 pages. Industrial Vinyls, Inc., 5511 N. W. 37th Ave., Miami, Fla. O

Circle 631 on Page 19



Whitney MSL Chain is lubricated for life by oil-impregnated, sintered steel bushings—an exclusive development of Whitney Research. With this development, Whitney solves a basic chain problem . . . **more damage is caused by faulty chain lubrication than by years of normal service.** Pressure and heat cause built-in lubricant to expand and flow from bushings, providing a constant supply of lubricant to every working part of the chain. When drive stops, bushings re-absorb oil, ensuring a permanent oil supply for the life of the chain. By solving the lubrication problem, and because of other important design advantages, Whitney MSL Chain outlasts conventional chain as much as 5 to 1 in severe operating environments.

Critical Area 1

PIN—Protective film of oil completely lubricates the live bearing area between pin and bushing, minimizing wear by reducing metal-to-metal contact.

Critical Area 2

PLATES—Whitney oil-impregnated sintered steel bushings extend beyond surface of inside plates to: act as lubricated thrust bearings, control clearance, and provide an oil cushion between plates, eliminating plate galling and seizing frequently caused by misalignment of sprockets.

Critical Area 3

SPROCKET ENGAGEMENT — Oil film on exterior surface of Whitney MSL Sintered Steel Bushings provides constant lubrication between sprocket teeth and chain. Whitney MSL Chain requires no rollers, as the tough oil film on the bushing surface provides smooth sprocket engagement, cushions impact and reduces drive wear.

Whitney oil-impregnated bushings—developed through continuous Whitney Research—are produced exclusively by Whitney to assure MSL Chain users of highest quality and reliability.

Inherent material characteristics of Whitney Sintered Steel Bushings, plus bushing configuration that provides greater contact area between bushings and links, permit high interference fit, which pre-loads links and gives maximum fatigue resistance.

Controlled clearance between plates promotes self-cleaning action.

WHITNEY MSL CHAIN MEETS ASA STANDARDS

All essential dimensions of Whitney Standard and Extended Pitch MSL Chain conform fully to ASA Standards, making it completely interchangeable with any similiar pitch ASA standard chain, simplifying specification for new equipment, or as a replacement for existing drives.

Whitney MSL Chain is carried in stock by Distributors in all parts of the United States, for prompt delivery.

***Maximum Service Life**

Whitney CHAIN COMPANY

Advanced Design Is a Whitney Tradition

A Subsidiary of Foote Bros. Gear and Machine Corporation

302 WEST HAMILTON STREET — HARTFORD 2, CONNECTICUT

Circle 500 on Page 19

Daddy isn't the boss...

He's just in charge of putting gears in the machines. But he doesn't growl anymore when he comes home. Mommy says he doesn't worry now about bad gears and not getting them on time since they buy them from CINCINNATI GEAR.

Why not investigate the advantages of having your gears and gear boxes made to suit your needs exactly? CINCINNATI gears are precision made, precision inspected, GUARANTEED—with delivery dates as promised. Ask us to quote on your requirements.

CINTI®

THE CINCINNATI GEAR CO.

Wooster Pike and Mariemont Ave. Cincinnati 27, Ohio
Custom Gear Makers Since 1907

GEARS, good gears only

Electric Motors

Unitized motors with ratings from 1/1000 through 1/15 hp are described as to design, application, and performance in Bulletin GEA-6882. Included 4-page technical data section discusses features and advantages. These motors are made in 59-frame, shaded-pole, and permanent-split capacitor models. 16 pages. General Electric Co., Schenectady 5, N. Y. C

Circle 632 on Page 19

Pushbutton Switches

Full-color pictures are used in Catalog 67 to show features of Series 2 lighted indicator and pushbutton switch devices. Parts simply snap together to form combination switch-indicator devices. Diagrams give dimensions and engineering information. 20 pages. Minneapolis-Honeywell Regulator Co., Micro Switch Div., Freeport, Ill. K

Circle 633 on Page 19

Purge Rotameters

Bulletin 18P is descriptive of a line of Purge rotameters for indicating and manually controlling small flows of water, air, and other fluids. Maximum operating pressure is 200 psi and temperatures range to 200° F. Design and operating features are explained. 4 pages. Schutte & Koerting Co., Instrument Div., Cornwells Heights, Bucks County, Pa. E

Circle 634 on Page 19

Temperature Control

Designed for applications with spans up to 200° F between the limits of 150 and 600° F, Type E36N indicating temperature controllers have list price of only $55. Full information on these accurate instruments are given in Technical Data Sheet 50. 2 pages. United Electric Controls Co., 85 School St., Watertown 72, Mass. B

Circle 635 on Page 19

Air Line Accessories

Among Airmatic in-line accessories described in Bulletin 91021 are pressure regulators, strainers, flow control valves, sequence valves, and quick exhaust valves. 8 pages. Airmatic Valve, Inc., 7313 Associate Ave., Cleveland 9, Ohio. G

Circle 636 on Page 19

Motors & Generators

Squirrel-cage ac, special, wound-rotor, and dc motors, generators and motor-generator sets are illustrated in bulletin. Units from 1 to 200 hp and motor-generator sets from ½ to 150 kw are covered. 6 pages. Imperial Electric Co., 84 Ira Ave., Akron 9, Ohio.

Circle 637 on Page 19

Copper & Brass Tube

Listing, with applicable specs and typical uses, of copper, copper-zinc, leaded brass, and tin brass tubing is provided by selector folder. Sizes listed are 3/16, ¼, ⅜, and ½ in. 4 pages. Scovill Mfg. Co., Mills Div., 99 Mill St., Waterbury 20, Conn. B

Circle 638 on Page 19

Plastic Pipe

Ace-Ite is a general-purpose plastic pipe for use in processing, mining, marine, and industrial operations. It is available in ⅜ to 4-in. sizes for service in the temperature range of −40 to 170° F. Full information on this corrosion resistant pipe and companion fittings are given in Bulletin CE-80. 16 pages. American Hard Rubber Co., Ace Road, Butler, N. J. D

Circle 639 on Page 19

Special Steels

Technical Data Brochure deals with the heat treatment and mechanical and physical properties of Unimach I and Unimach II high strength, high temperature steels for critical structural applications in airborne vehicles. Graphs show tensile and yield strengths, temperature properties, and stress-rupture curves. 36 pages. Universal-Cyclops Steel Corp., Station Street, Bridgeville, Pa. G

Circle 640 on Page 19

Valved Couplings

Features of the new 15 Series of quick-connect quick-disconnect valved couplings for use with fuels and other fluids at working pressures to 3000 psi and temperatures to 400° F are presented in Catalog 280B. Six sizes are available in sizes from ¼ to 1¼ in. Variations include types for remote operation and for handling liquified gases. 4 pages. Snap-tite, Inc., Union City, Pa. F

Circle 641 on Page 19

Transfer Switches

Bulletin 07500-G highlights relay control features of the Trans-O-Matic automatic transfer switches and features the new narrow control center model. Switches have dual circuit breaker design and are designed for 600-v, 800-amp service with interrupting capacities to 50,000 amp rms. 4 pages. Lake Shore Electric Corp., 205 Willis St., Bedford, Ohio.

Circle 642 on Page 19

F

Steel Heat Treatment

"Modern Principles of Heat Treatment of Steel" is title of technical booklet describing the derivation and meaning of the TTT diagrams and giving fundamentals of various heat treating procedures, including step-annealing, martempering, and austempering. TTT diagrams for commonly used grades of SAE tool steels are furnished. 28 pages. Uddeholm Co. of America, Inc., 155 E. 44th St., New York, N. Y. D

Circle 643 on Page 19

Wear Resistant Alloy

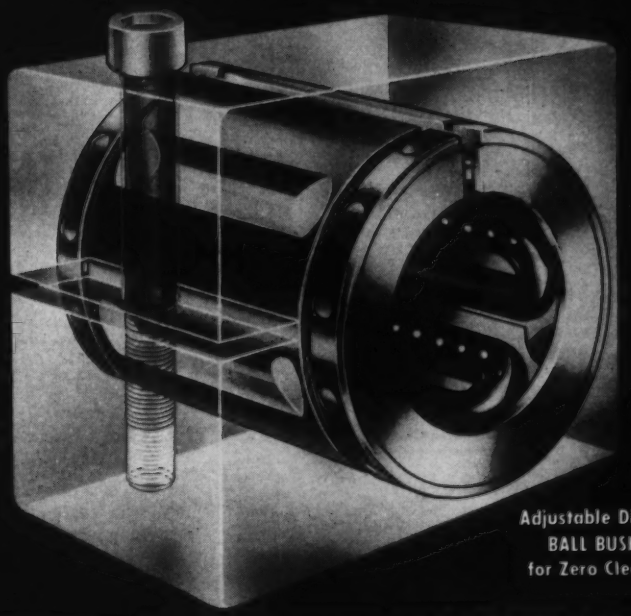
Eleven cobalt and iron base alloys developed specifically for wear resistance are covered as to their heat treatment, joining, machining, and grinding in Bulletin F-30,133. Engineering data as well as as chemical, physical, and mechanical properties are given in easy to use form. 32 pages. Haynes Stellite Co., 420 Lexington Ave., New York 17, N. Y. C

Circle 644 on Page 19

Circle 502 on Page 19→

NOW! *Adjustable Diameter and Open* THOMSON

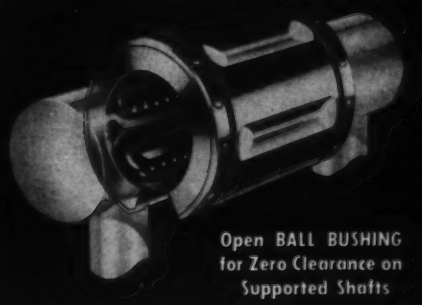
BALL BUSHINGS



Adjustable Diameter BALL BUSHING for Zero Clearance

The BALL Bearing for *all* your **LINEAR MOTIONS**

Precision Series "A" and Low Cost Series "B" BALL BUSHING



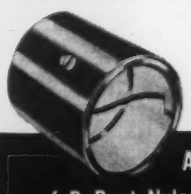
Open BALL BUSHING for Zero Clearance on Supported Shafts

Sliding linear motions are nearly always troublesome. Thousands of progressive engineers and designers have solved this problem by application of BALL BUSHINGS on *guide rods, reciprocating shafts, push-pull actions,* or for support of *any mechanism that is moved or shifted in a straight line.*

Improve your product! Up-date your design and performance with Thomson BALL BUSHINGS!

LOW FRICTION • ZERO SHAKE OR PLAY
ELIMINATE BINDING AND CHATTER
SOLVE SLIDING LUBRICATION PROBLEMS
LONG LIFE • LASTING ALIGNMENT

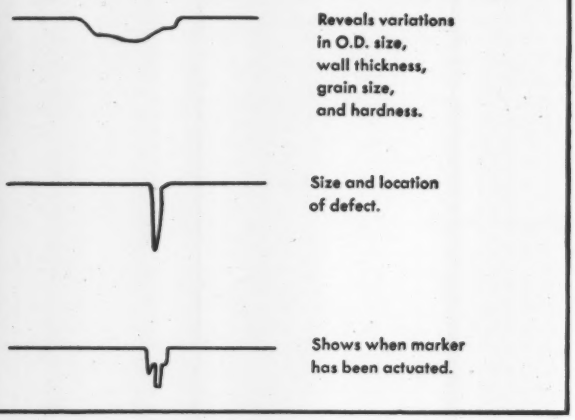
The various types cover a shaft diameter range of ⅛" to 4". Small sizes available in Stainless Steel. Write for literature and name of our representative in your city.



THOMSON INDUSTRIES, Inc.
Dept. E, MANHASSET, NEW YORK

Also Manufacturers of NYLINED Bearings . . . Sleeve Bearings of DuPont Nylon, and 60 CASE . . . Hardened and Ground Steel Shafting

NEW DAMASCOPE TEST


Reveals variations in O.D. size, wall thickness, grain size, and hardness.
Size and location of defect.
Shows when marker has been actuated.

This flaw is .004 square inches in area
Damascope revealed exact size and location

Here is a new and improved method of eddy current inspection that guarantees each and every piece of Damascus pressure tubing will meet your specifications. Damascope reveals not only the presence of flaws, but their exact size and location. Tubes with surface or sub-surface cracks, seams, splits, holes and inclusions are automatically indicated and rejected.

Over one million inspection feet were run to prove the new test which Damascus now employs as a regular production check on pressure tubing quality.

DAMASCOPE "Eddy Current" Test Meets ASTM Area Size Limits on Flaws

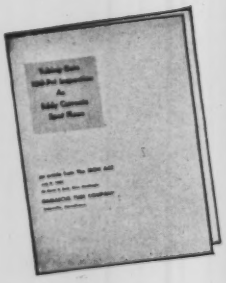
Gauge	Wall Thickness (in.)	Minor Dimension of Defect (Length or Depth) (in.)	Area Size Length x Depth (sq. in.)
20	0.035	0.005	0.0020
18	0.049	0.006	0.0024
17	0.058	0.007	0.0028
16	0.065	0.008	0.0032
15	0.072	0.009	0.0036
14	0.083	0.010	0.0040

Tubing passed by Damascope is guaranteed to meet A.S.T.M. specifications as outlined in the Book of Standards, Part 1, covering ferrous metals.

If you employ more stringent requirements, Damascope can be set to even finer sensitivity to yield a super tube at only a slight premium.

NUCLEAR APPLICATIONS

Damascope is one of the first eddy current methods of inspection to be approved for tubing used in critical nuclear work. It has been accepted because of the unique design of Damascope and because power surges previously responsible for variations in test criteria have been eliminated.



FOR COMPLETE INFORMATION ON DAMASCOPE TESTING

Write today for four-page bulletin explaining operation and other pertinent data on Damascope inspection.

DAMASCUS TUBE COMPANY

STAINLESS STEEL TUBING AND PIPE

GREENVILLE, PENNSYLVANIA

Circle 503 on Page 19

Liquid Meters

Functions, applications, and operation of Rockwell Turbo-Meters are described in Bulletin OG-417. Used in petroleum pipelines, meter will register 15,000 barrels of liquid per hour. It features sustained accuracy, regardless of viscosity. 12 pages. Rockwell Mfg. Co., Meter & Valve Div., 400 N. Lexington Ave., Pittsburgh 8, Pa. F

Circle 645 on Page 19

Welded Metal Bellows

Design manual with special slide rule contains mathematical formulas for computing reasonable design parameters for welded metal bellows, for use as volumetric expansion devices, pressure sensors, rotary and linear seals, aneroids, stem seals, expansion joints, and gimbal joints. 20 pages. Belfab Corp., 909 Hobson Ave., Hamden, Conn. B

Circle 646 on Page 19

Subminiature Switches

Available with from 1 to 8-pole, double-throw contact arrangements, 5300 Series subminiature toggle-actuated switches are rated 5 amp resistive and 3 amp inductive at 30-v dc and 115-v ac. Bulletin 53T-1 descriptively covers the full line of these switches. 4 pages. Haydon Switch, Inc., Waterbury 20, Conn. B

Circle 647 on Page 19

Metal O-Rings

Design Manual 359 presents engineering data on application and installation of all types of metal O-ring gaskets. Size and groove dimensions for O-rings made from 0.035, 0.062, 0.094, and 0.125-in. diameter tubing are tabulated. 12 pages. Advanced Products Co., 59 Broadway, North Haven, Conn. B

Circle 648 on Page 19

Hose Fittings

Push-lok fittings and industrial hose for air, water, oil, and fuel service at pressures under 250 psi are detailed in Catalog 4482. Fittings are offered with seven different connecting ends. 8 pages. Parker Hannifin Corp., 17325 Euclid Ave., Cleveland 12, Ohio. F

Circle 649 on Page 19

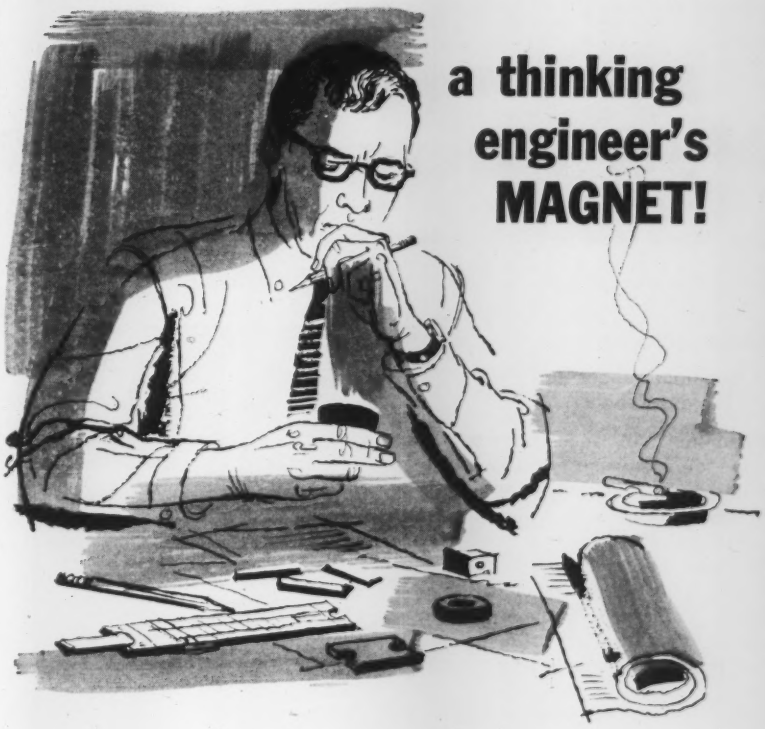
Pressure Pickup

Bulletin 1620 describes the Type 4-326 pressure pickup capable of absolute and gage measurement to 10,000 psi. It has provision for external adjustment of temperature compensation, sensitivity, and bridge balance. 2 pages. Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif. L

Circle 650 on Page 19

Power Drive Calculator

In easy step-by-step form, this slide rule type calculator computes the proper roller chain and sprocket for every type of drive. All necessary technical data are provided. Each of 10 steps in the procedure is detailed. Available only when requested on company letterhead from Atlas Chain & Mfg. Co., Dept. C, West Pittston, Pa. E



a thinking engineer's MAGNET!

If your pending engineering creations are as original as many we've encountered recently, there's quite likely a place in them for Stackpole Ceramagnet. Molded from ceramic powders, these permanent magnets are totally unlike conventional metallic magnets — both in *how* and *where* they can be used.

For instance, Ceramagnet permanent magnets are electrically nonconductive and chemically inert. In addition, their high coercive force means that they may be magnetized before assembly and used without keepers and pole pieces, or in the presence of strong opposing fields without loss of flux.

Ceramagnet has space advantages too! Axial dimensions may be decreased, radial dimensions increased. Thin discs containing many poles on one flat face are often practical.

Ceramagnet permanent magnets usually show decided price advantages in larger sizes, in complex shapes, or in large quantities requiring a minimum of machining.

Where can Ceramagnet fit into your application? For ideas and complete specifications, send for Stackpole Bulletin RC-12A. STACKPOLE CARBON COMPANY, St. Marys, Pa.

ONLY CERAMIC MAGNETS COULD MAKE THESE NEW PRODUCTS PRACTICAL..

1. A durable, electrically-operated remote-indicating water meter for home & industry.
2. A power station lightning arrestor that resists arc burning . . . lasts far longer.
3. Light-weight, dry-circuit relay and circuit breaker arc-snuffers that require no additional insulation.
4. Smaller, quieter automotive auxiliary motors.
5. Lower cost, more easily assembled door and cabinet latches.
6. Low-cost magnetic drives that require no physical coupling between driving- and driven-members.

CERAMAG® FERROMAGNETIC CORES SLIDE AND SNAP SWITCHES • VARIABLE COMPOSITION RESISTORS • CERAMAGNET® CERAMIC MAGNETS • FIXED COMPOSITION CAPACITORS • COLDITE 70+® FIXED COMPOSITION RESISTORS • ELECTRICAL CONTACTS • BRUSHES FOR ALL ROTATING ELECTRICAL EQUIPMENT • HUNDRED OF RELATED CARBON, GRAPHITE, AND METAL POWDER PRODUCTS.

STACKPOLE CeraMAGNET®

Circle 504 on Page 19

New Parts and Materials

Use Yellow Card, page 19, to obtain more information

Shock Absorber

combines rubber and alloy-steel chain

Cushion Chain shock absorber has wide application in any type of machinery or equipment subject to shock loads or impact forces. Unit combines cushioning properties of special rubber compound with high strength of alloy-steel chain. Rubber is permanently bonded to chain, with links in contracted position, under heat and pressure in a special mold. Rubber is under shear, compression, and tension in different

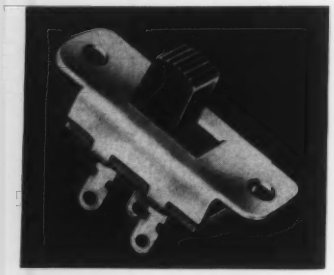
sections of shock absorber as it functions under load. Shock absorber is available in various sizes and capacities. **Brandon Equipment Co. Inc.**, Dept. B-2, 332 S. Michigan Ave., Chicago 4, Ill. J

Circle 651 on Page 19

Slide Switch

is rated 6 amp at 125 v ac

Tiny slide switch, Type SS-36-1, is for use on appliances, power tools, instruments, and other electrical products requiring a low-cost, heavy-duty switch. Unit is rated 6 amp at 125 v ac. Single-pole, double-throw contacts can be connected for single-pole, single-throw operation by omitting wiring to one end terminal. Trigger knobs are available in nine colors, and either



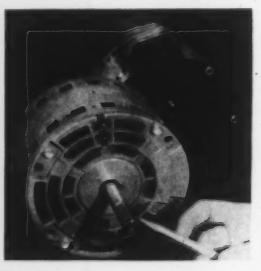
silver-plated solder-lug terminals or gold-plated printed - wiring terminals are available. **Electronic Components Div., Stackpole Carbon Co.**, St. Marys, Pa. N

Circle 652 on Page 19

Fractional-Horsepower Motor

for heating and air-conditioning use

Fractional - horsepower, 48 - frame motor is up to ½ in. shorter than previous design to provide greater compactness. New design is for shaded-pole motors to ¼ hp and permanent-split-capacitor types to 1/3 hp. Motor will operate for minimum of 5 yr without lubrication, under normal conditions. Locked-type washer system practically eliminates washer noise, since all moving parts are separated from stationary parts by a continuously maintained oil film. Mounting styles include rigid or resilient, band, end mount with single or double-extended studs, or halo mount. Either line leads or a ter-



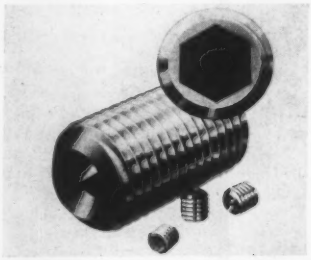
minal board are mounted over vent holes in frame. **Westinghouse Electric Corp.**, P. O. Box 2099, Pittsburgh 30, Pa. F

Circle 653 on Page 19

Socket Set Screw

has high resistance to vibration

W-Point socket set screw has a cone point centered within the cup edge. Point makes contact with engaged work before cup edge. Screw provides high back-out torque, resistance to vibration and to rotary slippage. Screw tracks evenly with a well-defined groove, resulting in positive frictional contact of both flanks of cup with engaged work. Screw is made in No. 4 to 1-in. diam in alloy steel, and No. 4 to ½-in. in stainless steel. Threads are ground to Class 34 tolerance. All popular sizes are avail-



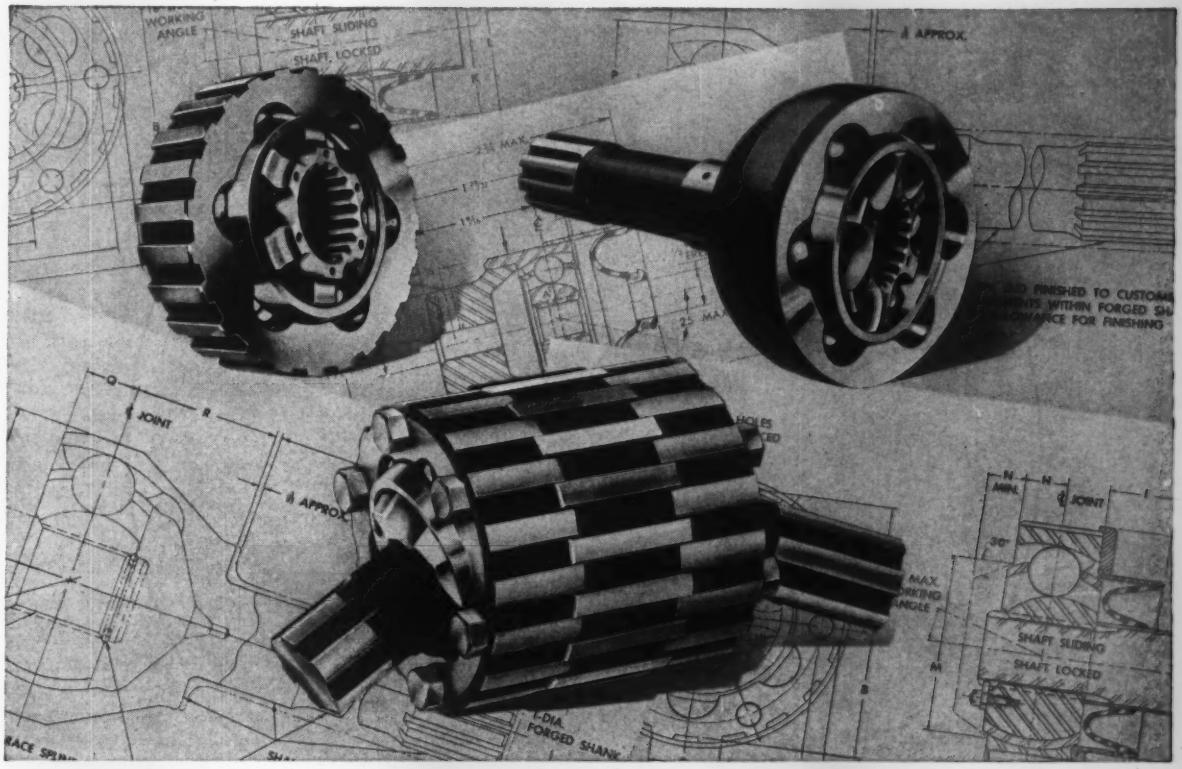
able, and other sizes can be furnished to order. **Parker-Kalon Div., General American Transportation Corp.**, Clifton, N. J. D

Circle 654 on Page 19

Steel Balls

for temperatures to 900 F

Precision balls of M-10, vacuum-melted, high-speed steel are available in 13 standard sizes from 1/16 to ½ in. Other standard and special sizes can also be supplied on request. Balls are made to pre-



RZEPPA UNIVERSAL JOINTS Now A Product Of DANA

New Con-Vel Division To Produce Famed Constant Velocity Universal Joints—With These Advantages To You:

- INCREASED SPEEDS
- REDUCED DOWN TIME
- LOWER MAINTENANCE COSTS
- HIGHER CAPACITY

Rzeppa universal joints provide perfectly smooth torque all the time, every time, even at angles up to 35°! Rzeppa rules out bounce, chatter, vibration by keeping the hardened steel driving ball bearings in the correct bisecting plane, no matter what the shaft angle may be. The smoother, constant velocity performance of Rzeppa joints naturally increases shaft and bearing life; adds to over-all efficiency and economy of operation.

Rzeppa universal joints are available in a wide variety of sizes, angles, speeds and styles . . . designed for front drives, articulating axles, propeller shafts, and scores of special applications. For information on their many advantages write to—

DANA Con-vel

CON-VEL DIVISION
DANA CORPORATION
3901 CHRISTOPHER, DETROIT 11, MICHIGAN

Circle 505 on Page 19

"Dad believes in good guns and good gun manners"

"He just bought me a new gas-powered Hahn BB rifle. It's real sharp and shoots straight, but he won't let me use it alone until I've learned good gun manners."

Hahn BB guns, styled after famous lever-action Western frontier rifles, have the look and feel of Dad's guns—and they shoot straight. This is due to the accuracy of the barrels. They are made from commercial grade Superior carbon steel tubing —known for the consistent uniformity of its ID finish, free machining characteristics and economy.

Examples of other unusual applications of this Superior tubing

- Carbon steel rectangular tubing for collimating tubes in a research reactor (.900 in. x .400 in. ID x .025 in. wall in 10-ft. cuts)
- Specially conditioned ID tubing in long lengths used as high pressure diesel lines on earthmoving equipment (¼ in. OD x .088 in. ID)
- Cadmium plated compression sleeves for connecting the steel core of ACSR high tension cable (.404 in. OD x .179 in. ID in 5-in. cuts)
- 2½ million ft. of carbon steel tubing in random lengths for the gear pinion in the timing fuse of artillery shells (.204 in. OD x .067 in. ID)

Filling tubing orders that range from a few feet to millions, in a wide variety of materials, shapes and sizes, calls for the resources Superior has to offer. Why not investigate the advantages of using us as a source of tubing. Bulletin 41, a guide to the selection and application of Superior tubing, is yours for the asking. Write Superior Tube Company, 2010 Germantown Ave., Norristown, Pa.

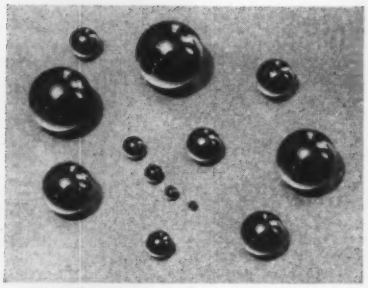
Superior Tube

The big name in small tubing

NORRISTOWN, PA.

All analyses .010 in. to ⅜ in. OD—certain analyses in light walls up to 2½ in. OD

West Coast: Pacific Tube Company, 5710 Smithway St., Los Angeles 22, Calif. • RAymond 3-1331



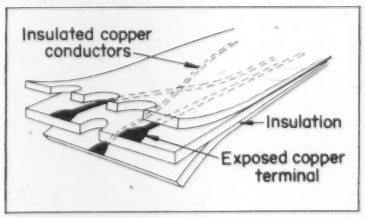
cision tolerances of ±0.00001 in. on size and sphericity, and have surface finish of 2 microinches rms. They are suitable for bearings and other components operating at temperatures to 900 F. **Industrial Tectonics Inc.**, 3686 Jackson Rd., Ann Arbor, Mich. H

Circle 655 on Page 19

Flexible Etched Circuitry

has conductors embedded between plastic

Custom-designed flexible etched circuitry can be produced in straight cables or complex wiring patterns, in single or multilayer constructions. Conductors are embedded between two sheets of thermoplastic that have been fused into one homogeneous mass to eliminate environmental problems such as salt spray, polarization, and oxidation. Bond between copper conductors and most plastics is equivalent to Class A hermetic seal, with bond strength over 7 psi. Other plastic surfaces can also be treated for adhesion to chassis or frames. Circuitry replaces both conventional wiring and rigid printed-wiring boards. It provides maximum flexibility with less weight, minimum assembly time with elimination of wiring errors, excellent electrical properties, and environmental protection. Circuits can be formed in an infinite variety of metallic etched patterns, sandwiched between two or more layers of plastic. Conductors are usually copper, but other metals such as brass, bronze, and aluminum have been used successfully.



Plastic material varies with application. **International Resistance Co.**, 401 N. Broad St., Philadelphia 8, Pa. E

Circle 656 on Page 19

Wire Forms and Assemblies

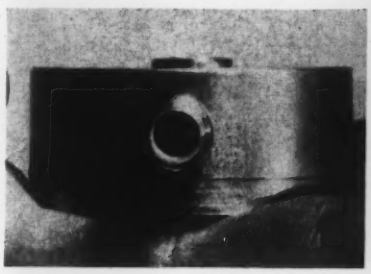
have colored zinc plating

New zinc plating process in six basic colors provides a choice of wire or strip components and assemblies that resist corrosion and rust. Unlimited choice of colors is available in any desired degree of density. Plating is applied to basic steel wire and is given a colored chromate treatment and baked clear lacquer coating. Applications include appliance trim, home and gift items, and office equipment. Basic colors are blue, green, purple, deep pink, copper, and brass, with a blend of any or all for varying shades. **E. H. Titchener & Co.**, 57 Clinton St., Binghamton, N. Y. N

Circle 657 on Page 19

Pancake Air Cylinders

are small, low-pressure units



Flat, low-pressure air cylinders permit utilization of air power within limited space. Cylinders are available in pressure ratios from 1:1 to 3:1 and with strokes from 0.01 to 1 in. Three sizes in push type are presently available. Pull type and specials, as well as other sizes, can be furnished on request. **Fabco**, 1231 Main Ave., Cleveland 13, Ohio. F

Circle 658 on Page 19

Indicator Light

miniature unit is for electronic equipment

Tiny, moistureproof miniature indicator light is only 15/64 in. in diam

Another PLUS value...

HANDLES BILLIONS SAVES MILLIONS

That's the record piled up by Rex, the *original* TableTop chain. In breweries, food processing plants and packaging handling operations, it has handled *billions* of containers...saved *millions* in man-hours, money, materials and maintenance.

TableTop is simplicity itself...just a one-piece platform link and pin. Smooth, beveled link edges assure tip-free transfers. Mail the coupon.

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Circle 507 on Page 19

Aircraft Components Manufacturer Specifies

OSTUCO *Forged Tubing*

FOR LOWER MACHINING COSTS

Forging tube end in Shelby mill. In addition, Ohio Seamless can supply tubing flared, swaged, expanded, upset, flanged, shaped, etc.

"Our machining time on this landing gear part in SAE 4140 plummeted from *400 to 180 minutes* when we changed from forgings to Ostuco Forged Tubing.

"In addition to getting *over 80% more parts per workshift*, we like the free-machining qualities of Ostuco tubing that give us extra savings in set-up time and tool grinding costs . . . "

These actual figures, from an eastern manufacturer, indicate the machining economies Ostuco Forged Tubing can effect in your product. The starting point is to call your nearest Ohio Seamless office, listed in the Yellow Pages, or the plant at *Shelby, Ohio — Birthplace of the Seamless Steel Tube Industry in America.*

AA-8850

OSTUCO TUBING

OHIO SEAMLESS TUBE DIVISION

of Copperweld Steel Company · SHELBY, OHIO

Seamless and Electric Resistance Welded Steel Tubing • Fabricating and Forging

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and 35/64 in. long. It is designed for electronic equipment requiring components of absolute minimum size and weight. Designated L10000, unit supplies bright, wide visibility for 60,000 hr at 5 v dc, 0.06 amp. Lamp-lens assembly is molded to mounting stem, making light completely moistureproof. Lenses are

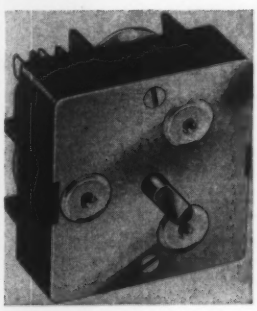
available in many translucent colors. Equipped with stranded wire leads and threaded anodized case, light mounts in a clearance hole for No. 10 screw. **Hetherington Inc.**, 1420 Delmar Drive, Folcroft, Pa. E

Circle 659 on Page 19

Cycle Timer

has wide choice of speeds

Cycle timer, known as Series AC-42, is a totally enclosed, motor-driven switching device for use in control of equipment such as vending machines, hand dryers, and photocopying equipment. Timer repeats a set cycle or sequence of switching operations as long as motor circuit is energized. Motor can be wired through switch contacts to limit rotation to one cycle. Wide choice of speeds makes possible many timing intervals. Housing of molded phenolic provides rigid, dust-tight construction that assures reliable performance under adverse ambient conditions. Single SPDT switch is rated at 25 amp or 1/3 hp



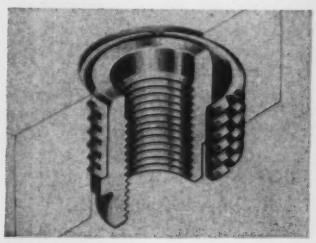
at 250 v ac. Timer is available for 120 or 240-v operation at 50 or 60 cps with choice of 18 timing intervals. **Haydon Div., General Time Corp.**, 245 E. Elm St., Torrington, Conn. B

Circle 660 on Page 19

Corrosion-Resistant Insert

requires only hole drilling

S110 insert, which meets fastener requirements in aircraft and missile structures, electronic equipment, engines, and accessories provides load-bearing, wear-resistant, self-locking threads for holes in materials such as plate or cast aluminum, magnesium, and cast iron. Insert, which can be used in open or blind applications, requires hole drilling only. It has excellent push-out, torque-out, and tensile-strength values, can be used in temperatures to 450 F, and meets self-locking and fatigue-test standards. Internally



threaded, stainless-steel expander is pulled into externally grooved, alloy-steel sleeve, prepositioned in work hole. This results in an interference fit between the two pieces, swells sleeve, and forces its external grooves into sides of hole. Variety of installation tooling is available. Insert accommodates six thread sizes from 6-32NC-3B to $\frac{3}{8}$-24UNF-3B. **Hi-Shear Rivet Tool Co.**, 2600 W. 247th St., Torrance, Calif. L

Circle 661 on Page 19

Gang Connector

for miniature coaxial cable

Compression-type Hyfen gang connector for miniature coaxial cable has pin and socket contacts crimped to both inner and outer conductors. Plug-and-receptacle unit presently connects RG195U cable and No. 24 shielded miniature coaxial cable.

Another PLUS value...

Stops
HOLDUPS
in your production

Want continuous production...to cut installation costs? Investigate the advantages of Rex Segmental Rim Sprockets and Traction Wheels. Tough, long-lasting special cast steel rims bolt simply to either split or solid hub body. When, after long service life, replacement is required, all you do is replace the worn rim...the hub body remains on the shaft. Mail the coupon.

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Circle 509 on Page 19

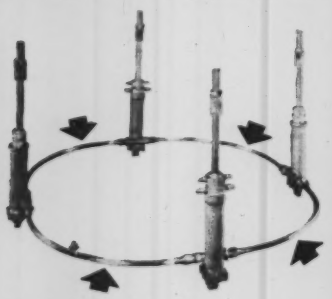
S.S.White

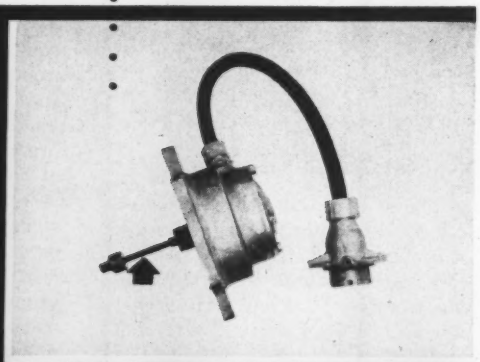
DRIVE AND CONTROL IDEAS FOR ENGINEERS

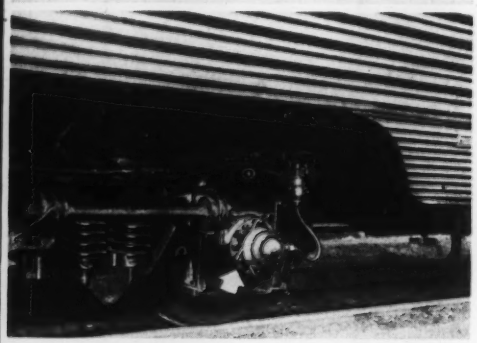
Tips on better designing with flexible shafts

REMOTE CONTROL

Reliable synchronization at high temperature is made possible by S. S. White flexible shafts on this actuator system for jet afterburner nozzles. The job assigned the shafts was to synchronize the system to permit multipoint installation and smooth, even application of power . . . at ambient temperatures up to 650F! To see how flexible shafts simplify design, picture doing this with solid shafts, gearing, universals, and other paraphernalia, around a 360° bend . . . and then imagine installing it!







POWER DRIVE

Running cool at 45,000 rpm! The S. S. White flexible shaft on this grinder-miller permits the use of carbide and diamond tools at speeds that were previously unknown to hand tools. The flexible shaft drives the handpiece from a ¼-hp motor suspended over the table at speeds up 45,000 rpm, without overheating and without vibration. A good point for designers to note is that in many cases, the higher the speed of a flexible shaft, the better the performance.

COUPLING

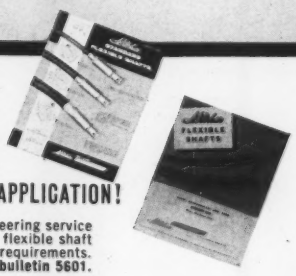
Alignment and vibration problems are solved by an S. S. White flexible shaft on this railroad brake controller. The device detects wheel slippage during braking, by means of rotary switches on each axle that detect changes in relative movement between pairs of wheels on the truck. If damaging slip occurs, the device releases brake pressure until slippage stops. A flexible shaft is fitted to the axle and drives the rotor in the switch, eliminating alignment problems and preventing excessive axle vibration from reaching the sensitive device.

1056

S.S.White

FIRST NAME IN FLEXIBLE SHAFTS

S. S. WHITE INDUSTRIAL DIVISION (Dept. 4)
10 East 40th Street, New York 16, N. Y.



Standard S. S. White flexible shafts are available "off the shelf," making many savings possible. **Write for bulletin 5801.**

USEFUL DATA ON SELECTION and APPLICATION!

S. S. White also offers engineering service and comprehensive selection of flexible shaft sizes and types to meet special requirements. **Write for bulletin 5601.**

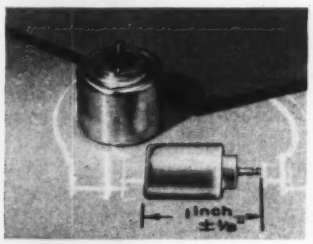
Connector frames accommodate three, five, or eight inserts, snapped in from either front or back. Inserts for coaxial cable accommodate up to 21 pins or sockets. Plug-or-receptacle insert holds either male or female contacts or a mixture of both. Cable inserts and standard wire inserts can be mounted in same frame. Engaging and disengaging forces of low magnitude make it easy to insert, remove, and replace contacts and insert individually, for flexibility in circuit changes. **Omaton Div., Burndy Corp.**, Norwalk, Conn. B

Circle 662 on Page 19

Tantalum Capacitors

have operating temperature range of −55 to +125 C

Liquid electrolyte tantalum capacitors are available with ratings to 150 mfd at 30 v and 50 mfd at 90 v. Capacitors meet applicable military requirements in MIL-C-3965B and other similar specifications. Op-



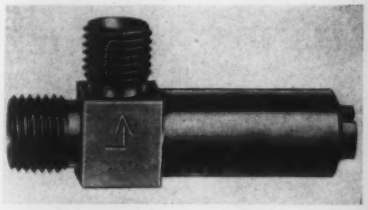
erating temperature range is −55 to +125 C. Units are hermetically sealed and meet salt-spray, shock, vibration, moisture-resistance, reduced-pressure, and other similar tests. Case is ⅞ in. diam and is at ground potential. Electrical leakage is low, and capacitance variation with temperature is at a minimum. **Magnavox Co.**, Dept. 822, Ft. Wayne, Ind. J

Circle 663 on Page 19

Relief Valve

for cracking pressures from 700 to 900 psi

No. 33-2139-000 relief valve prevents over-pressurization of aircraft fuel system where relief of short surges of high pressure is needed. Designed with a damping chamber to prevent chatter, valve is externally adjustable for cracking pressures from 700 to 900 psi. Typical unit holds zero leakage to 700 psi with



850 psi cracking pressure. Weight is 0.2 lb maximum. **Aero Supply Mfg. Co. Inc.**, Corry, Pa. F

Circle 664 on Page 19

Motor Pulley

in 1 to 15-hp sizes

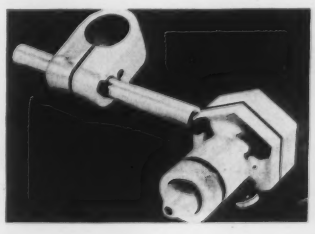
Adjustable-speed drive-motor pulley features all-area greasing system, with free distribution of grease to bearing points, single lubrication point on end of pulley, and grease reservoir for easy maintenance and long life. Single movable flange and totally enclosed separate spring cartridges provide simplicity of design. Pulley, in 1 to 15-hp sizes, can be mounted on Angle-matic motor base, designed to maintain proper belt tension through entire range of speed change. **Worthington Corp.**, Harrison, N. J. C

Circle 665 on Page 19

Atomizing Nozzle

for spray application of lubricants and coatings

Adjustable - discharge atomizing nozzle which utilizes only one moving part is available for spray application of lubricants, adhesives, and other liquid coatings. Simple adjustment gives precise control over quantity of flow and size and shape of spray pattern. Positive shut-off at nozzle orifice insures dripless operation. Manifold air and liquid connections allow nozzle assembly to be removed without disturbing nozzle mounting or hose lines. Unit operates at atomizing pressures of 1 to 100 psi. Mount-



Another PLUS value...

POSITIONED TO HANDLE LOADS

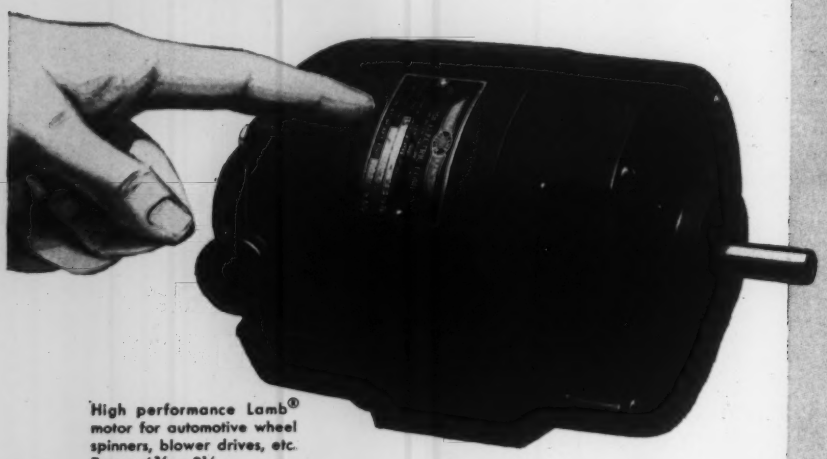
To provide the ability to stand up under heavier loads and higher speeds, bushings in all Rex Roller Chains are carefully positioned in the link plates with the seams facing each other on the pitch line. Thus, the load is always *on* the strongest part of the bushing...always *away* from the seam. It's one of the many *PLUS VALUE* features of Rex Roller Chains that make them first choice where maximum fatigue strength and wear life are required. For all the facts, mail the coupon.

REX®
ROLLER CHAINS

CHAIN Belt Company 400
4643 W. Greenfield Ave.
Milwaukee 1, Wisconsin
(In Canada: CHAIN Belt Canada Ltd., 1181 Sheppard Ave. East, Toronto, Ontario)
☐ Send me my copy of Bulletin 5725, "The Plus Values in Rex Roller Chains."
☐ Have a Rex Man call.
Name.....
Company.....
Address.....
City.....*Zone*.....*State*.....

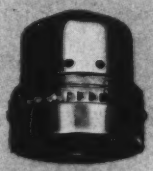
Circle 511 on Page 19

This Motor May Be the Answer...

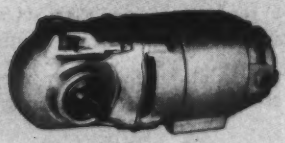


High performance Lamb® motor for automotive wheel spinners, blower drives, etc. Frame 4⅜ x 2¼

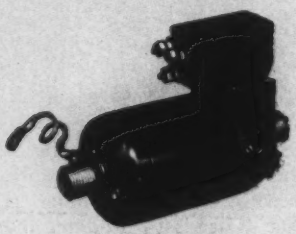
Skeleton frame motor for vegetable juicer. Frame 3⅛ x 1⅜



⅛ Horsepower two-stage motor blower unit for light duty commercial vacuum cleaners.



Gearmotor with one stage of spiral bevel gears for portable disc sander. Frame 3¹⁵⁄₁₆ x 2⅛



24 Volt DC aircraft motor for windshield wiper drive. Includes radio interference filter. Frame 2½ x 1½

If You Want Greater Dependability for Your Motor-Driven Product

Lamb Electric is an *engineering* and *manufacturing* company, whose entire resources have been devoted for nearly half a century to the development and *mass production* of *special application*, fractional horsepower electric motors . . . *and nothing else.*

This is important to you if your product lacks sufficient life and dependability, if you are paying too much for electric motors, or your product is bulky or too heavy. Our unique qualifications are also important to you if you are planning a new product and want to start off with the right motor.

We invite your inquiry.

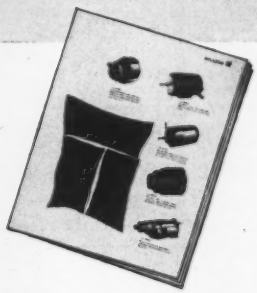
THE LAMB ELECTRIC COMPANY • KENT, OHIO

A Division of American Machine and Metals, Inc.

In Canada: Lamb Electric • Division of Sangamo Company Ltd. • Leaside, Ontario

Lamb Electric

SPECIAL APPLICATION FRACTIONAL HORSEPOWER **MOTORS**



Write for your copy... 8-page folder describes these and other Lamb Electric motors.

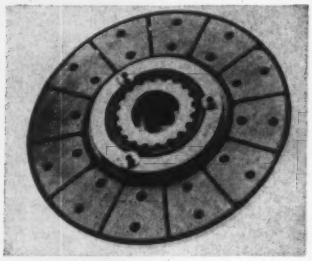
ing bracket is available to set nozzle in fixed position if desired. **Columbus Automatic Lubrication Co.**, 81 E. State St., Columbus 15, Ohio. G

Circle 666 on Page 19

Spline-Drive Armatures

for heavy-duty uses

Spline-drive armatures are available for use on integral-horsepower electric clutch-coupling and brake applications where shock loading or vibration loading are problems. Assemblies are furnished in 8, 10, 12, and 15-in. diameters. A splined hub and mating split, tapered bushing fasten armature to shaft. Armatures can also be used on special clutch applications where male



splined hub is furnished. Armature is pressed tight against magnet face at completion of mounting, and on release, air gap is set automatically by autogap spring. Automatic compensation for magnet and armature wear is provided by autogap spring, which always maintains automatic 1/32-in. gap when unit is disengaged. **Warner Electric Brake & Clutch Co.**, Beloit, Wis. K

Circle 667 on Page 19

Running-Time Meters

register from 0.1 sec to 99,999 hr

Type 632 time totalizers record elapsed time in industrial or laboratory operations. Time ranges available are seconds or tenths of seconds, minutes, tenths, or hundredths of minutes, and hours, tenths, or hundredths of hours. Units register from 0.1 sec to 99,999 hr. High-torque, instant-start-stop motor drives drum-type counter. External connections can be arranged to operate meters during equipment running time, idle time, or any operational phase. In all time ranges, meters are available with or without reset, and in her-

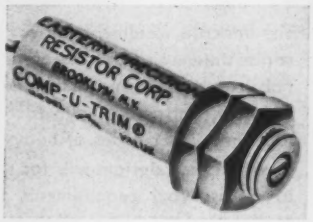
metically sealed cases which meet applicable specifications of MIL-E-5272A. Motors can be specified for 115 or 220 v ac, 60, 50, or 25 cycles. In limited time ranges, they can be specified for 115 v, 400-cycle ac, or for any voltage between 6 and 32 v dc. **Cramer Controls Corp.**, Centerbrook, Conn. B

Circle 668 on Page 19

Trimming Potentiometer

is only 5/16 in. in diameter

Model F wire-wound linear trimming potentiometer is designed to allow for mounting through front panel of equipment or for below-chassis mounting. Only 5/16 in. in diam, unit has all-aluminum housing which withstands adverse environments. Potentiometer meets or exceeds applicable specifications of MIL-R-19, MIL-202, and MIL-5272. It is rated 0.75 w at 85 C and 0.5 w at 125 C. It is available in resistance ranges from 10 to 50,-



000 ohms with tolerance of ±10 per cent and temperature coefficient of ±20 ppm. **Eastern Precision Resistor Corp.**, 675 Barbey St., Brooklyn 7, N. Y. D

Circle 669 on Page 19

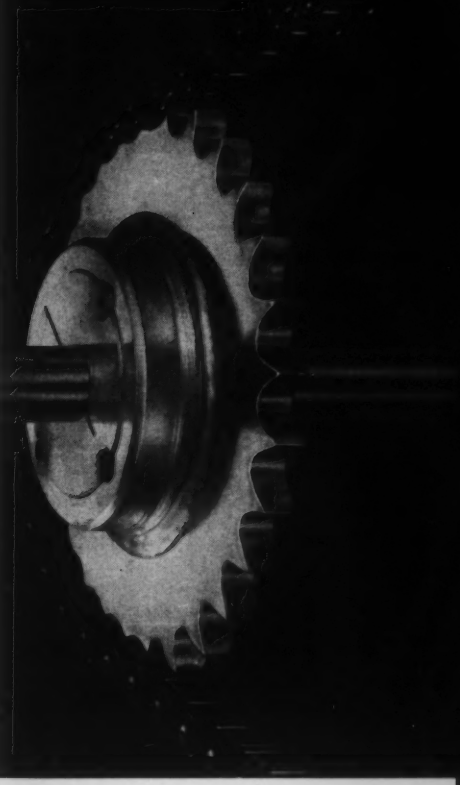
Air Valves

are momentary-contact types

In new momentary-contact air valves, current is applied only for time it takes valve to change position. Valve remains in that position with power off. When electric

Another PLUS value...

CUT RIGHT...
NOT
"CUT RATE"



Sprockets that are *not* cut right can cut chain life by as much as 50% to 75%. For smoothest action...for maximum service life of both chain and sprockets, cut-tooth sprockets must be made to precise tolerances. Rex Cut-Tooth Sprockets are made to exact tolerances to fit precisely with the chain for longest life of both chain and sprockets. For more data, mail the coupon.

REX®
CUT-TOOTH SPROCKETS

CHAIN Belt Company 408
4643 W. Greenfield Ave., Milwaukee 1, Wis.
(In Canada: CHAIN Belt Canada Ltd., 1181 Sheppard Ave. East, Toronto, Ontario.)
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Circle 513 on Page 19

STEEL-WELD FABRICATION . . .

PRECISION WELDMENTS

Fabricated and Machined to Specification!

The intricate weldment above, which is one of several components of a radar antenna's base mechanism, is typical of thousands of Steel-Weld Fabricated parts and assemblies produced and machined by Mahon for defense contractors, manufacturers of processing machinery, machine tools and other types of heavy mechanical equipment.

When your design calls for weldments of any kind, you, too, will want to discuss your requirements with Mahon engineers; because, in the Mahon Company you will find a unique source for weldments or welded steel in any form . . . a fully responsible source with a long and enviable performance record, and unusual facilities for design engineering, fabricating, machining and assembling.

See Sweet's Product Design File for information on Facilities, or have a Mahon sales engineer call at your convenience.

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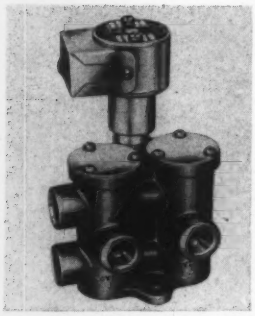


impulse once more energizes solenoid (in single-solenoid, two-position, four-way valve), solenoid plunger releases contact device and allows pilot valve and main valve members to revert to normal position. Solenoid is de-energized and valve remains in this position until next actuation. In dual-solenoid units, for use in automated systems, solenoid No. 1 is actuated and pilot valve is latched as in single-solenoid type. Additional electric impulses to solenoid No. 1 will not release pilot valve; only when solenoid No. 2 is actuated will valve revert to normal position. **Barksdale Valves**, 5125 Alcoa Ave., Los Angeles 58, Calif. L

Circle 670 on Page 19

Delrin Stock Shapes

in sheets, rods, and tubes

Delrin shapes can be used for gears, bearings, rollers, casters, slides, and pump parts. Small-diameter rods are now available, and sheets, tubes, and large-diameter rods will soon be furnished. **Cadillac Plastic & Chemical Co.**, 15111 Second Ave., Detroit 3, Mich. H

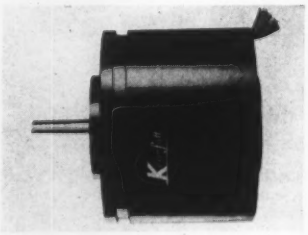
Circle 671 on Page 19

Size 10 Servomotor

is lightweight unit for high temperatures

Size 10 model P112-001 servomotor operates effectively at temperatures from −54 to +200 C. It is a small, lightweight precision unit capable of high performance under high temperature. Unit has high torque-to-inertia ratio. Stator, integrally cast in a thermosetting resin, permits straight-through bores and minimum air gaps. Stall torque is 0.035 oz-in., and no-load speed is 3800 rpm. **Kearfott Co. Inc.**, 1500 Main Ave., Clifton, N. J. D

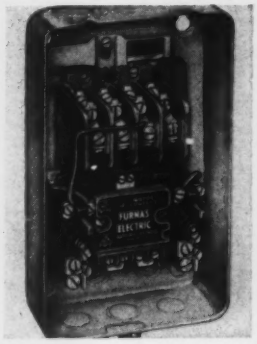
Circle 672 on Page 19



Magnetic Starters

are rated through 15 hp

Magnetic motor starters are molded from glass - fiber - filled material which is noncracking, fungus resistant, and moisture resistant. Blocks are impact resistant to withstand severe blows. Starters, rated through 15 hp, 440-550 v, incorporate removable front components, dual-voltage coils reconnectable on the job, and trip-free thermal overload relays with trip indicators. Encapsulated, dual-voltage magnet coils are rated 110-220 or 220-440 v, 50-60 cycles. Molded terminal board in each coil eliminates leads and simplifies coil-voltage selection. Coil accepts plug-in pushbutton or selector switch. **Furnas Electric Co.**, 1045 McKee St., Batavia, Ill. I



Circle 673 on Page 19

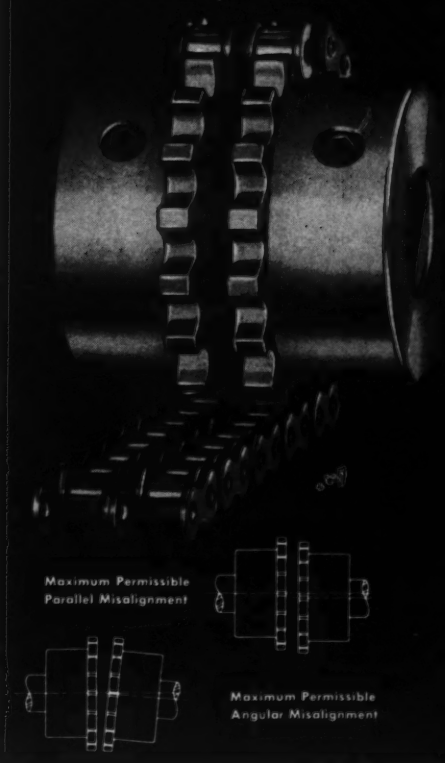
Adjustable-Speed Drives

in 20 and 25-hp ratings

Compact adjustable-speed drives permit accurate, infinite speed adjustments while in operation, and offer 3:1 speed range. Available in 20 and 25 hp Class II ratings, drives have service factors to 1.4, and have constant torque characteristics. Components available include 414 adjustable belt, 412 ad-

Another PLUS value...

PROTECTION AGAINST MISALIGNMENT



For positive protection against unavoidable misalignments...for positive power transmission...for high strength and long life...at low cost, use all-steel Rex Roller Chain Flexible Couplings. They compensate for both angular and parallel misalignment... absorb shocks and vibration...provide maximum flexibility with minimum backlash. For complete, cost-saving facts...compare! Mail the coupon.

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Circle 515 on Page 19

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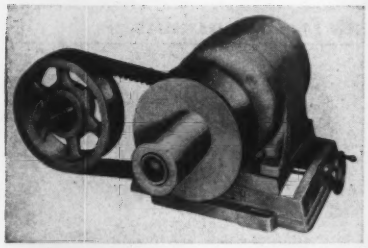
Circle 516 on Page 19



justable base for mounting 324U and 364 frame motors, and selection of controlling devices. Variety of companion sheaves gives wide choice of operating speeds. **Lewellen Mfg. Co.**, 1412 Tenth St., Columbus, Ind. J

Circle 674 on Page 19

Endless Belts

of Teflon-impregnated glass fabric

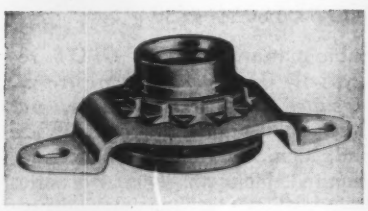
Endless belts are especially suited for resin conveyors and heat-sealing applications. Fabric exhibits nonstick characteristics of Teflon, preventing resin buildup while passing through preheat ovens. Since base cloth is composed of glass fibers, belt can operate into 400 F range without being affected. Surface can be cleaned easily when changing production materials. Films will not adhere to Teflon surface, even at flow temperatures. Belts are available to order in widths to 50 in., and 0.01-in. thick fabric. Lighter or heavier belts can also be furnished in any required length. **Technical Service Dept., General Plastics Corp.**, 165 Third Ave., Paterson, N. J. D

Circle 675 on Page 19

Floating Anchor Nuts

for temperatures to 1400 F

Two high-tensile, self-locking, all-metal anchor nuts are for high-temperature applications requiring high torque-out and push-out characteristics. F19270 is A286 stainless for 1200 F use, and F19271 of M252 stainless is for 1400 F service.



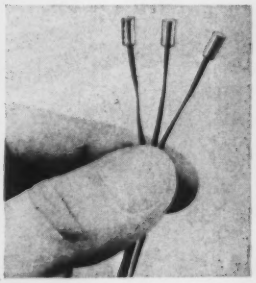
Retainers can be of any material compatible with structure to which they are fastened. **Kaylock Div., Kaynar Mfg. Co. Inc.**, Box 2001, Terminal Annex, Los Angeles 54, Calif. L

Circle 676 on Page 19

Resistance Thermometer

miniature unit is for temperatures to 500 F

Resistance thermometer, Model S-22, has a diameter of 0.156 in. and length of 0.281 in. It provides reliable operation in temperatures from −100 to +500 F. Resistance is 470 ohms at 32 F, and varies at rate of about 1 ohm per deg F. Plat-



inum sensing element is potted for maximum environmental capabilities, dielectric, and mechanical strength. Stainless-steel case withstands a minimum of 5 lb compressive force from a rigid load. Calibration accuracies of ±¼, ½, and 1 per cent are available from stock. Curves, points, and/or equations are available with each unit. **Minco Products Inc.**, 740 Washington Ave. N., Minneapolis 1, Minn. J

Circle 677 on Page 19

Filter Assemblies

for operating pressures to 5000 psi

Dual-bowl filter assemblies, Series 5868, for high-pressure, high flow-capacity fluid systems have a wide range of filtration ratings. Two standard filter elements are used in a single housing. Six different filter media are available for filtration from 2 to 250 mu and temperature ranges from −350 to +350 F. Filter assemblies are for system operating pressures to 5000 psi; rated burst pressure is 12,000 psi. Assemblies can be furnished with or

Another PLUS value...

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VIBRATION

Even under car-shaker vibration that loosens tons of coal, Shafer Bearings keep their steel grip on longer life.

This reserve stamina stems from exclusive bearing design and precision construction. Concave rollers matched to convex raceways are of highly elastic, case-hardened alloy steel. With every shock, rollers compress, increasing bearing surfaces.

Even under misalignment, Shafer Bearings roll safely with the punch. Mail the coupon.

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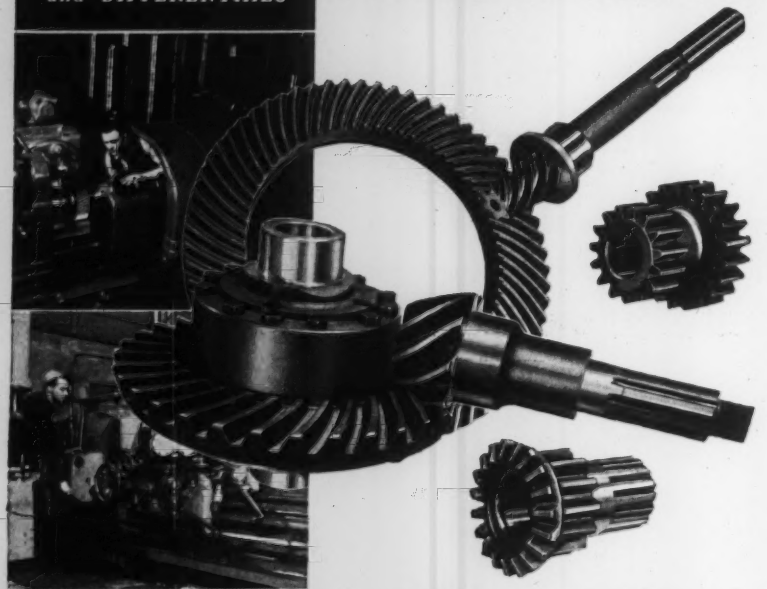
Circle 517 on Page 19

GEARS
and DIFFERENTIALS

made to Your order by
FAIRFIELD



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Simple arithmetic explains why, TODAY, many of America's leading machine makers no longer undertake to solve the problems involved in production of gears, differentials, and specially designed gear parts. For them, FAIRFIELD IS THE ANSWER!

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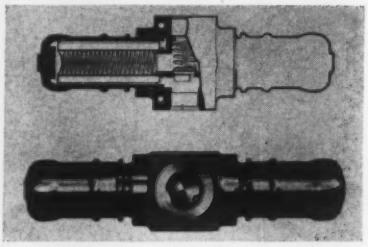
Circle 518 on Page 19



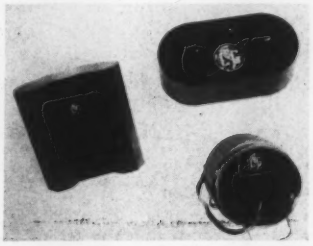
without bypass valve. Equipped with proper filter element, assemblies filter liquid oxygen, liquid nitrogen, aviation gasoline, kerosene, water, acetone, alcohol, air, lubrication oils, and other related fluids. **Bendix Filter Div., Bendix Aviation Corp.**, 434 W. 12 Mile Rd., Madison Hts., Mich. H

Circle 678 on Page 19

Battery Power Packs

resist shock to 2000 g

CG Power Packs consist of permanently rechargeable nickel-cadmium battery cells, potted in a plastic case for production in any size, shape, color, and electrical capacity. Designed for use in satellites, missiles, rockets, and telemetry applications, units can be fabricated into configurations seldom possible with



standard round or square batteries. Batteries have proven shock resistance to 2000 g. **Alkaline Battery Div., Gulton Industries Inc.**, Metuchen, N. J. D

Circle 679 on Page 19

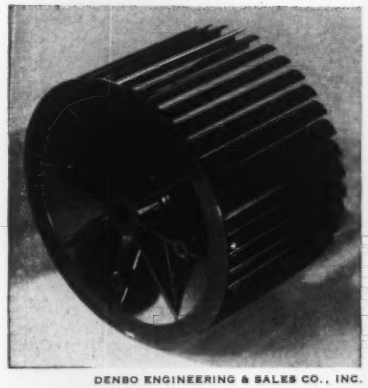
Subminiature Relay

resists vibration to 5000 cycles at 30 g

Subminiature polarized DPDT relay, only 0.8 x 0.4 x 0.9 in. in size, is suited for aircraft, missile, and other applications where small size and high vibration resistance are required. Hermetically sealed Series 33 relay has vibration immunity to

PRODUCT-DESIGN BRIEFS FROM DUREZ

- **a phenolic that simplifies**
- **plastic that foils vandals**
- **resins that bind**



DENBO ENGINEERING & SALES CO., INC.

Breezy brainwork

Q. What's missing from this blower wheel?

A. The ring that you'd expect to see steadying the blades at the far end.

Who forgot it? Nobody. In this wheel it's superfluous. Without the ring, air enters the wheel more freely. There's more working blade area. Air flow can be modified at the factory, without retooling, simply by shortening the blades.

You can't make a wheel like this out of metal—not at a marketable price, anyway. But a general-purpose Durez phenolic works fine.

Concentricity is molded in. Wobble is much less than could be achieved economically in a metal wheel. The wafer-edged blades are rigid enough to do without tip support. They can't be bent in shipment or in assembling the blower into any appliance of which it is a part. The wheel withstands moisture and mild corrosive atmospheres; retains its shape through the range of temperatures at which it will operate.

You don't make blower wheels? All right. We're happy if we have implanted an idea for *anything* you might construct better or more cheaply with a Durez general-purpose phenolic. For still more ideas on where and how to apply these durable, versatile materials, send in the coupon requesting Bulletin D400.

Vandalproof

Big-city switchblade artists used to rip the stuffings out of upholstered bus seats—to the tune of $100,000 a year in damage.

Then city transit authorities ordered 330 new buses with glass-reinforced plastic seats like the ones you see here. Made with tough, fire-retardant Hetron® polyester, these seats can't be slashed, defy destruction.

They cost less to make than upholstered seats. And the passengers like them better—voted overwhelmingly in favor of them in rider reaction tests.

Now transit officials plan to replace *all* the city's buses with vehicles featuring these vandalproof seats.

AMERICAN SEATING COMPANY

Where can *you* see a market for strong reinforced-plastic shapes that retard fire? There's a whole family of Hetron resins to help you do your visualizing. Hetron is *inherently* self-extinguishing—gives fire retardance with no loss of mechanical strength. Heat resistance, moisture resistance, electrical properties of Hetron laminates and premix-molded shapes are outstanding.

To get a better idea of what you can do with these fire-retardant resins, use the coupon to request the complete Hetron data file.

KENTILE, INC.

A pinch of permanence

No, cooking does not improve the flavor of this cork tile.

We're just demonstrating the good strong bond that's possible, in a material such as cork, with Durez phenolic resins. Not even boiling water can weaken it.

Locking cork granules together is one of hundreds of bonding jobs these resins can do. You might want to delve into their equally salutory effects on rubber, paper, sand, asbestos, or ground wood.

Under heat, the resin softens, then sets hard, presenting thereafter a permanently stubborn front to heat, moisture, and abrasion. You can get resins that impart many different combinations of useful properties. It doesn't take much resin—often only one part in ten—to get the results you're looking for. And phenolic is one of the lowest-priced bonding agents you can buy.

If you want to know how you might add a pinch of permanence to a product, mail us the coupon. The bulletin you'll receive tells how 12 industries are doing this very thing with Durez resins.

For more information on the Durez materials mentioned above, check here:

- ☐ 8-page Bulletin D400 lists properties, uses, design advantages of general-purpose Durez phenolics and other thermosetting materials.
- ☐ Data file (50A) on Hetron fire-retardant polyester resins.
- ☐ Industrial applications of Durez phenolic resins (12-page bulletin).

Clip and mail to us with your name, title, company address. *(When requesting samples, please use business letterhead.)*

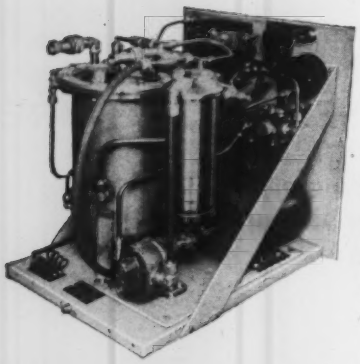
DUREZ PLASTICS DIVISION

510 WALCK ROAD, NORTH TONAWANDA, N. Y.

HOOKER CHEMICAL CORPORATION

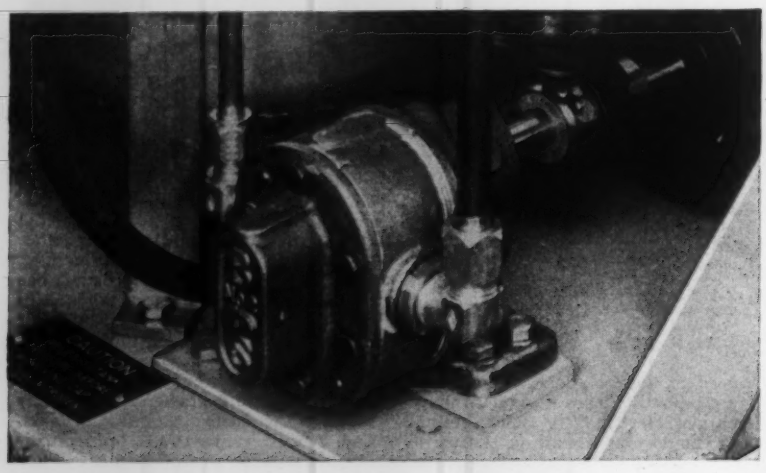
HOOKER CHEMICALS PLASTICS

Circle 519 on Page 19



Unit for cooling electron tubes in radar environmental test equipment — one of many products developed and manufactured by Industrial Control Products, Inc., Caldwell, N. J.

Why Industrial Control Products designers choose Brown & Sharpe pumps



Problem: Designers of this unit for cooling electron tubes needed pumps capable of handling an extraordinarily efficient new dielectric coolant: FC75. To prevent contamination, no ferrous metals could touch the fluid. 4 gpm delivery at 150 psi pressures must be maintained at temperatures from minus 60C to +100C. None of many standard and special pumps first tried was satisfactory.

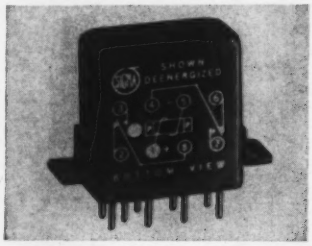
Solution: Brown & Sharpe was called in — developed special rotary geared pumps with bronze bodies; chrome-plated internal contact surfaces; chrome-plated stainless-steel gears; graphite bearings. The new B&S pumps performed perfectly — are now built into all these units.

Idea: For the best solution to any pump problem — write Hydraulics Division, Brown & Sharpe Mfg. Co., Providence 1, R. I. — or contact your nearest B&S engineer-representative. Brown & Sharpe makes gear, vane and centrifugal pumps to handle more fluids than any other manufacturer.

Brown & Sharpe
PRECISION CENTER

Circle 520 on Page 19

30 g at 5000 cycles. It provides two-position, magnetically biased operation at a standard sensitivity of 200 mw within temperature range of −65 to +125 C. Shock and constant acceleration to 100 g will not damage or open contacts. Contact rating is 2 amp for silver



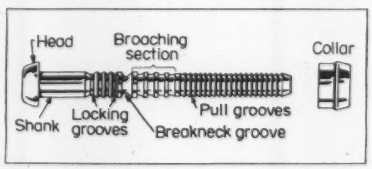
contacts, and 0.5 amp for gold-alloy contacts, recommended for dry-circuit operation. Unit is available with a single coil in flange, stud, or plate-mounting styles, and choice of J-hook terminals, eight-pin plug-in, or 3-in. wire-lead connections. **Sigma Instruments Inc.**, 170 Pearl St., South Braintree 85, Mass. B

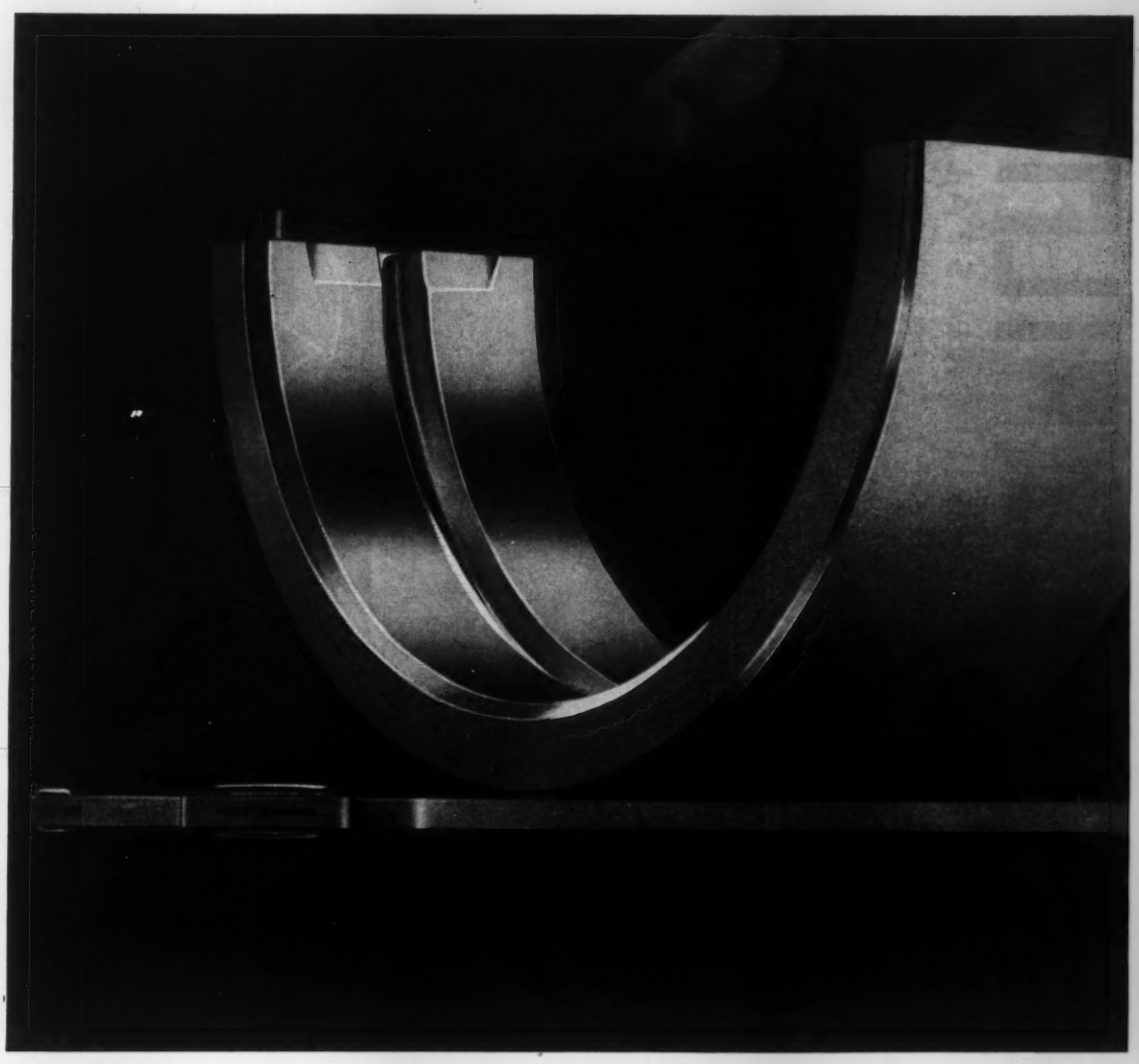
Circle 680 on Page 19

Close-Fit Fasteners

in self-broaching and self-sizing types

New fasteners which automatically produce optimum interference-fit installation are recommended for use in joining aluminum-alloy components. Self-broaching fastener, designated 10LP, is available in 3/16 and ¼-in. nominal pin diameters, lengths as required. Design contains a progressive broach integral with fastener pin. During installation, fastener pin is pulled through hole by installation tool. Fastener broach removes up to 0.01 in. of material on diameter, broaching drilled hole to a finish size which provides a precise, positive interference fit for that particular pin. Concept eliminates need for secondary broaching or reaming. Self-sizing fastener, 9LP, is also available in 3/16 and ¼-in. nominal diameters with lengths as re-





why use 19th century metals to carry 20th century loads?

for solid bearings, Alcoa Aluminum far outperforms old-fashioned metals ...and costs far less. Here are the facts:

DESIGNERS of a century and more ago *had* to rely on bearings of babbitt or bronze; better bearing metals just didn't exist.

BUT WHY should *you?* Not *cost*, certainly, for a typical aluminum alloy bearing sleeve costs as much as one-third less than other materials.

PERFORMANCE? Solid aluminum bearings support up to 10,000 pounds per square inch. Years of service in a host of applications from railroads to rolling mills show ability to stand up long after inferior metals have failed. Aluminum bearings run cooler—as much as 20° by actual test—because *no* other bearing metal is as good a heat conductor.

AND ALUMINUM bearings *last longer*, because they conform, thanks to aluminum's famous ductility. Because of aluminum's famed resistance to corrosion, especially to additives in lubricating oils. Because it embeds gritty particles that might cause abrasive wear and scoring. Because of their lower frictional resistance under heavy load, aluminum bearings permit immediate starting.

SO WHY rely on old-fashioned bearing materials? *Design around aluminum*—for maximum flexibility, optimum performance, minimum cost.

For further details, call your nearest Alcoa sales office, or write: Aluminum Company of America, 1837-K Alcoa Building, Pittsburgh 19, Pa.

Aluminum Bar Stock Now Available Locally!

Your nearby Bunting Distributor can now quickly fill your replacement bushing needs with cost-saving, high-performing Alcoa® Aluminum bars. He carries a complete line of 138 different sizes in solid and cored aluminum bar stock.

Call your Bunting Distributor for Alcoa Aluminum bars and save as much as 33⅓ per cent on your replacement bushing costs.

ALCOA ALUMINUM

Your Guide to the Best in Aluminum Value

For Exciting Drama Watch "Alcoa Theatre," Alternate Mondays, NBC-TV, and "Alcoa Presents," Every Tuesday, ABC-TV

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"THE ENGINEERED MECHANICAL SEAL"
because Dura Seal is backed by 25 years of experience — because Dura Seal is supported by continuous research for meeting modern processing demands — because Dura Seal is engineered to meet your specific operating conditions — because Dura Seal is nationally sold and serviced.
For Free Engineering Counsel on Your Sealing Problems, write DURAMETALLIC CORP., Kalamazoo, Michigan
Circle 522 on Page 19

quired. It contains an extruding land integral with pin. Drilled hole is expanded to proper size by extruding land as pin is pulled through by installation tool. **Huck Mfg. Co.**, 2480 Bellevue Ave., Detroit 7, Mich. H

Circle 681 on Page 19

Sanitary Casters

sealed units have 4 to 6 in. diameter

Sanitary casters are available for use where equipment sanitation is essential. Line is available in light, medium, and heavy-duty models with 4 to 6-in. diam wheels in either

swivel or rigid mount. Sealed casters eliminate need for periodic maintenance due to grease loss or entry of foreign matter. **Albion Industries Inc.**, Albion, Mich. H

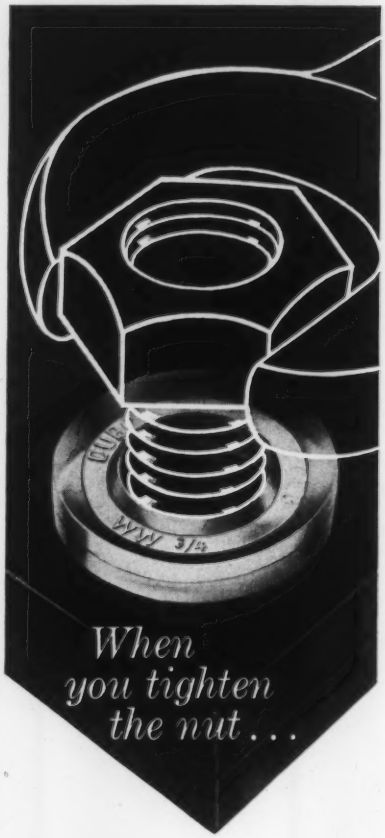
Circle 682 on Page 19

Insulating Materials

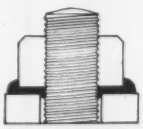
include three new coated types

Redesigned line of coated insulating materials includes bondable silicone-rubber tapes, black varnished polyester glass cloth, and Alkanex coated glass cloth. Bondable silicone-rubber tapes are available in both supported and unsupported form, either of which can be hand or machine taped. Tapes are suitable for use with electrical systems exposed to moisture, abrasives, and severe atmospheric contaminants. Supported tape can be applied over irregular shapes without folding or parting. It has all the electrical properties of unsupported silicone rubber. For applications where high flexibility is required and physical strength requirements are less demanding, unsupported silicone rubber tape is available. Black

This new lock and seal washer is just plain **REVOLUTIONARY...**



NYLOGRIP Dubo Lockwasher locks and seals it-instantly!



Patents Applied For

The new NYLOGRIP Dubo Lockwasher is made of a special, cold-flow plastic called Nylon 6. When the nut is tightened, the washer "flows" — its inner diameter grips into the threads of the nut and bolt, to seal this junction against leakage, while the outer diameter flows over the outer edges of the nut, seals and locks it . . . so tight neither shock nor vibration can budge it! The Dubo Lockwasher can be used time and again without the slightest loss of holding power. And, because it's symmetrical and has no threaded parts, you couldn't fit one incorrectly if you tried.

PLUS FEATURES: excellent electrical properties . . . exceptional wear resistance . . . good shock absorption . . . resists corrosion, chemicals . . . non-flammable . . . high flexural strength.

PLUS USES: The excellent electrical characteristics of NYLOGRIP Dubo Lockwashers make them ideal for electrical insulation, or to help control electrolytic corrosion between dissimilar metals.

YOU'LL WANT COMPLETE TECHNICAL INFORMATION.

Write today to:

NYLOGRIP PRODUCTS

570 Pleasant St., Watertown, Mass.-WA 6-0100

Non Metallic Fastenings of all types.

Circle 523 on Page 19

To get a big press back into action fast . . .

Bethlehem forged, rough-machined, and tested this cylinder in 6 weeks

1/21/59

The main high-pressure cylinder of a 2,750-ton hydraulic extrusion press fails, and brass rod production ceases.

The owner of the press, Titan Metal Manufacturing Company, Bellefonte, Pa., contacts Lake Erie Machinery Corporation, Buffalo, N. Y., who, although they did not make the press in question, are able to redesign and assist in rebuilding, since they are a leading hydraulic press manufacturer.

1/26/59

Lake Erie places an order for a new cylinder--forged and rough-machined--with Bethlehem. Specifications call for carbon steel, treated and tested; 68 in. max OD; 42 in. bore; 133 in. overall length.

3/10/59

Bethlehem completes forging and machining to exact specifications, and ships 72,460-lb cylinder.

3/26/59

Lake Erie completes finish-machining, and manufacture of component parts. Cylinder is installed, and press is back in action.

You may never require as big a forging as fast. Still, it's comforting to know that if the occasion does arise, Bethlehem can handle it. Our shops can meet your specifications on all types of drop, press, and hammer forgings, regardless of size or design.

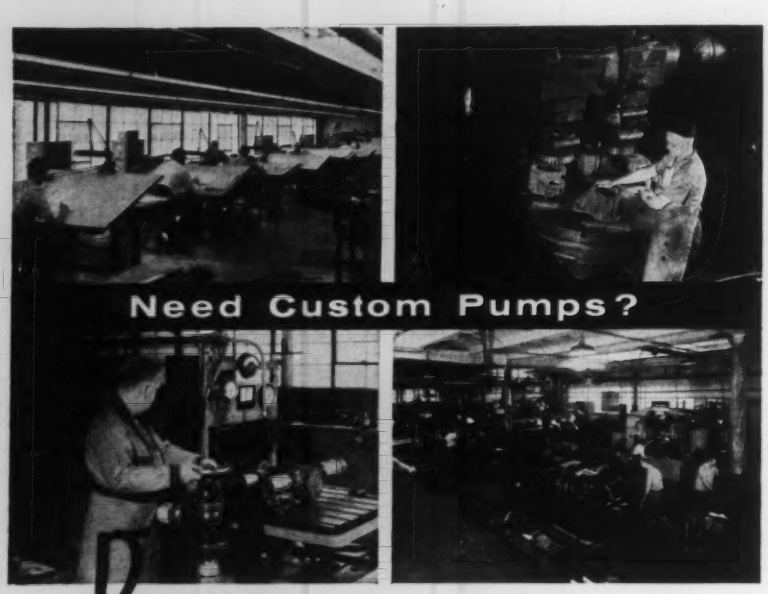
BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export distributor: Bethlehem Steel Export Corporation.

BETHLEHEM STEEL

BETHLEHEM STEEL

Circle 524 on Page 19



ROPER HAS KNOW-HOW AND FACILITIES TO GIVE YOU PERFORMANCE AND COST ADVANTAGES...

Here, at Roper, we sometimes get the comment: "We need a pump of a custom nature, but it appears we can produce it ourselves."

While we do not quarrel with the theory that a do-it-yourself project *may lead* to results wanted, we often question if such results are commensurate with the price paid in time, effort and capital expenditure. We prefer to think that our plant and our staff can produce custom pumps that *will* fill the bill — and at *appreciable savings* to the customer. We feel this way because Roper has specialized in manufacturing pumps for over a century, and has the up-to-date know-how and facilities to cope with any pumping problem.

If you are currently working on either high or low pressure systems . . . if size and weight are determining factors . . . if time and money are of great importance, then direct your inquiry to Roper for valuable assistance and dependable pumps. May we roll up our sleeves to help you?

ROPER
ROTARY PUMPS

ROPER HYDRAULICS, INC.
250 Blackhawk Park Avenue, Rockford, Illinois

Circle 525 on Page 19

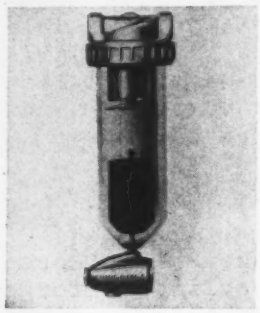
varnished polyester glass cloth insulation is a Class B material available as an all-purpose insulation. Dielectric strength increases after it is stretched during application. Alkanex coated glass cloth, designed for extremely high heat resistance, is rated for Class F operation. **General Electric Co.**, Schenectady 5, N. Y. C

Circle 683 on Page 19

Air-Line Filter

drains automatically

Auto-Drain filter, using pilot principle, incorporates a float which admits air to pilot-valve chamber whenever liquid accumulates, opening a scavenger valve. Trapped liquid and impurities are blown out drain opening automatically. Filter



is available in sizes from ¼ through 1 in. Transparent plastic bowls are supplied for pressures to 150 psi and metal bowls for pressures to 250 psi. **Industrial Div., Watts Regulator Co.**, 10 Embankment Rd., Lawrence, Mass. B

Circle 684 on Page 19

Lightweight Battery

compact unit
activates in 0.5 sec

Model P14A automatically activated silver-zinc battery provides 1 amp-hr of 28-v current for missiles where reliable auxiliary power and space requirements are critical. Lightweight, compact device has a high energy-to-weight ratio. Only 3 x 3 x 4.5 in. in size, battery contains 19 cells which are foil construction to reduce anode gassing and provide maximum reliability and freedom from short circuits. Battery provide 1 amp current with maximum current of 5 amp. Signal

42

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NO MAINTENANCE
NO WEARING PARTS

Future maintenance costs and shutdowns are eliminated when you install Thomas Flexible Couplings. These all-metal couplings are open for inspection while running.

They will protect your equipment and extend the life of your machines.

Properly installed and operated within rated conditions, Thomas Flexible Couplings should last a lifetime.

UNDER LOAD and MISALIGNMENT ONLY THOMAS FLEXIBLE COUPLINGS OFFER ALL THESE ADVANTAGES:

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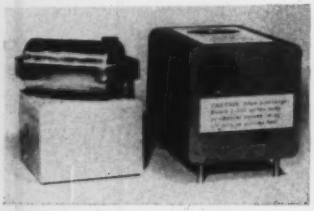
- No Lubrication
- No Wearing Parts
- No Maintenance

Write for Engineering Catalog

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA, U.S.A.

Circle 527 on Page 19



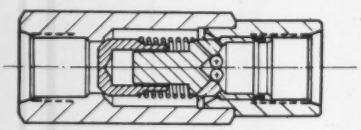
required for activation is 28-v at 2 amp, and activation time is only 0.5 sec. Unit withstands vibration to 10 g, acceleration to 20 g, and shock to 5 g in all three major axes. **Frank R. Cook Co.**, 3850 Olive St., Denver 7, Colo. K

Circle 685 on Page 19

Check Valves

have SAE straight-thread ports

Line of check valves has large passages which permit full-line flow and low pressure drop. Valves will not stick open because spherically lapped poppet eliminates need for close sliding fits. All parts are steel, and body is one piece. Featuring SAE straight-thread ports, valves



FLUID CONTROLS CHECK VALVE (SAE)

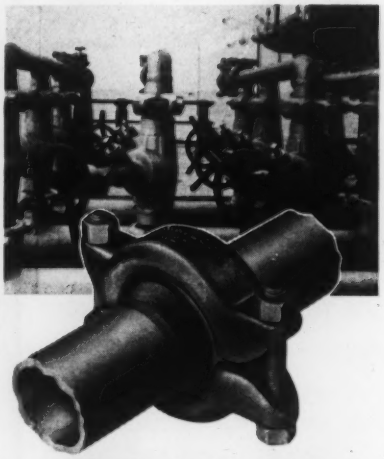
are for service to 5000 psi and burst pressures over 10,000 psi. Six sizes from ¼ to 1¼ in. are available. **Fluid Controls Inc.**, Box 186, Mentor, Ohio. G

Circle 686 on Page 19

Precision Potentiometers

withstand acceleration of over 40 g

New precision potentiometers have low noise, maximum resolution from 0.015 to 0.059 per cent and linearities from 0.08 to 0.2 per cent (standard) and 0.03 to 0.15 per cent (best). Maximum resistance per 360 deg ranges from 45,000 to 200,000 ohms for Type GC models. Depending upon requirements, potentiometers withstand acceleration of over 40 g and vibration of over 1000 cps. Standard operating temperature range is −55 to 120 C. Other outstanding features are low torque, excellent stability, and fungus-resist-



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SAVES 3 WAYS FOR OEM

Original Equipment Manufacturers save on space, weight, and time when reliable GRAYLOC is specified for piping connections for their products.

The compactness gained with space-saving GRAYLOC might make your product adaptable to more applications. Example: Five Grayloc-equipped valves can be installed in the space normally used for four flange-type valves in a manifold hook-up.

Weight-saving GRAYLOC makes many units easier to handle, certainly it will save you freight costs since GRAYLOC weighs up to 90% less than comparable-sized flange connections. Yet there is no loss of strength. Example: 4-inch GRAYLOC with a rating of more than 6,000 psi weighs 35 pounds compared to the 450 pounds of a flange connection with a comparable rating.

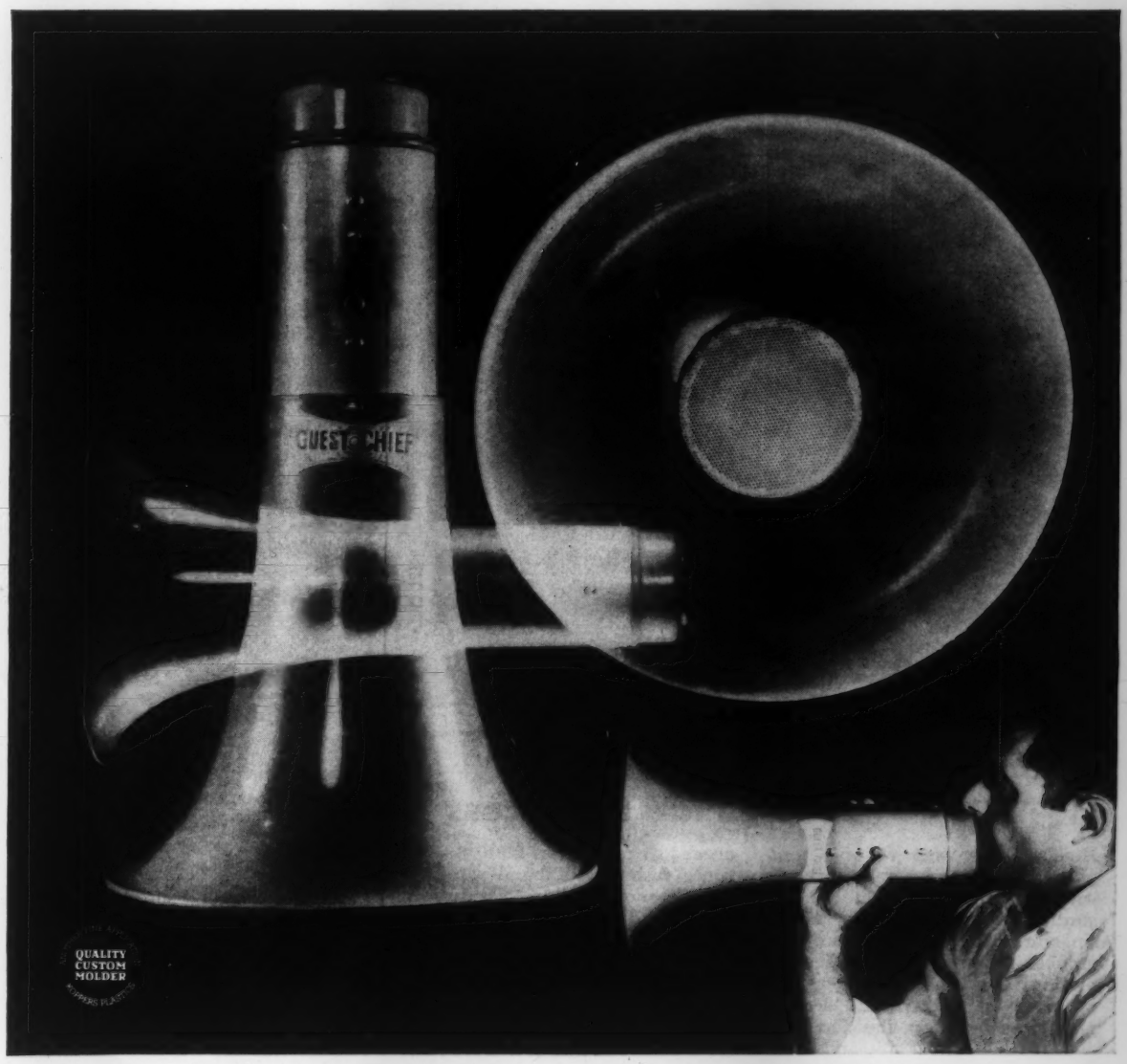
GRAYLOC connections can be made up in as little as 3 minutes time by unskilled laborers and are positively leak-proof every time.

GRAYLOC connections have practical applications wherever flanges are used. For additional information concerning the savings you can have with GRAYLOC, contact Gray Tool Company.

GRAY *Tool Company*

P. O. BOX 2291 HOUSTON, TEXAS
REpublic 4-1641 5907

Circle 528 on Page 19



Manufacturer: Industrial Television, Inc., Clifton, New Jersey • Molder: Shasta Mfg. Company, Berkeley Heights, New Jersey

Tough body for a big voice

This portable, battery-powered megaphone has a tough, strong bell made of SUPER DYLAN® high-density polyethylene —a plastic product of Koppers.

With its smooth, glossy, bright red SUPER DYLAN bell, the megaphone can take plenty of punishment. Moreover, SUPER DYLAN is dimensionally stable, lightweight, rust-proof and chemically inert. No painting. No chipping. No flaking.

So, if you need a tough, strong and colorful plastic material, be sure to consider SUPER DYLAN polyethylene. For further information on SUPER DYLAN, write on your company letterhead to Koppers Company, Inc., Plastics Division, Dept. MD-109, Pittsburgh 19, Pennsylvania.

Offices in Principal Cities · In Canada: Dominion Anilines and Chemicals Ltd., Toronto, Ontario

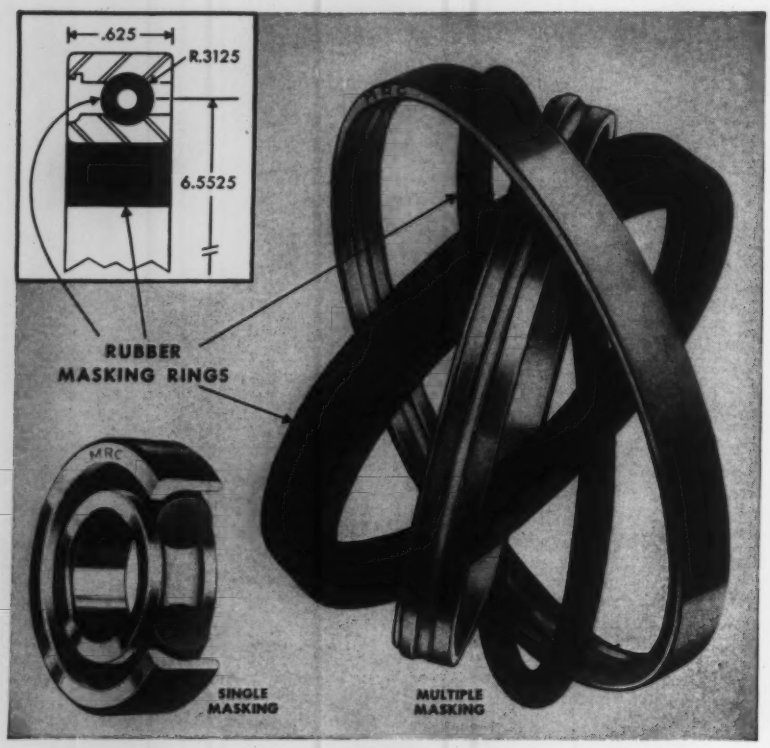
HIGH DENSITY

KOPPERS PLASTICS

KOPPERS

DYLITE® expandable polystyrene, DYLENE® polystyrene and DYLAN® polyethylene are other fine plastics produced by Koppers Company, Inc.

Circle 529 on Page 19



Photos courtesy Marlin-Rockwell Corp., Jamestown, N. Y.

Rubber Rings Mask Bearings during Plating Process

Here's a new way to mask out plating on bearing race grooves without tedious hand-labor. Regardless of bearing size, rubber rings are fitted precisely into ball grooves and inner ring bore so that plating can't sneak under the rubber even in torturous electroplating baths. Clean division lines always result. Inner ring and outer ring are held together so both can be plated simultaneously. This saves one complete plating cycle. And, this fast assembly prepares bearings for plating in seconds—eliminates costly hand-painting with unreliable stop-off lacquer.

These rubber rings are the result of Marlin-Rockwell Corporation (Jamestown, New York) consulting Continental to solve an important masking problem. Creative engineering successfully developed these extruded and spliced, or molded rubber rings which increased production 2000%—20 times faster than hand-painting. What's more, the special rubber compound withstands repeated baths in blistering acids and caustics without affecting precise dimensions, elasticity or resilience.

This rubber ring technique is typical of the thinking and ingenuity behind rubber parts by Continental. It also represents the economy and better end results accomplished by consulting a rubber specialist *during the planning stage* of a product. If you need help like this, call or write Continental —rubber specialists since 1903.

Engineering catalog.

In addition to custom-made parts, Continental offers an extensive line of standard grommets, bushings, bumpers, rings and extruded shapes. Hundreds of these are shown in the No. 100 Engineering Catalog. Send for a copy or refer to it in Sweet's Catalog for Product Designers.

Another achievement in **RUBBER**
engineered by **CONTINENTAL**

CONTINENTAL RUBBER WORKS • 1984 LIBERTY ST. • ERIE 6 • PENNSYLVANIA

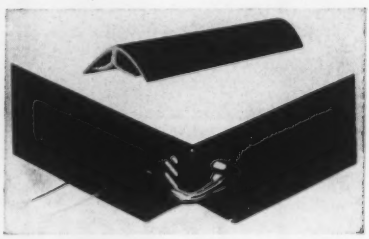
ant insulation capable of withstanding 250 v nominal and 1500 v breakdown. Noise level is 100 ohms at 4 rpm. Units can be ganged up to ten in any desired combination and can be supplied with internal or external clamps. Potentiometers have met MIL-E-5272B environmental qualifications tests for vibration, fungus, shock, humidity, temperature, salt spray, sand, and dust. **Guidance Controls**, 110 Duffy Ave., Hicksville, L. I., N. Y. D

Circle 687 on Page 19

Panel Wiring Accessory

provides rounded raceway corners

Corner Strip panel-channel wiring accessory is grooved on one side to slip onto ends of two panel channel sections set at right angles. Providing round raceway corners, it is furnished in 6-ft lengths that can be cut to required size. Strip can



be used with all sizes and types of panel-channel raceways. **Stahlin Brothers Inc.**, Belding, Mich. H

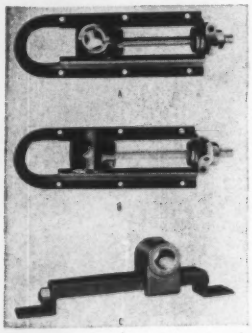
Circle 688 on Page 19

Bearing Takeups

for commercial shafting to 5 15/16 in. diam

Three series provide 74 new sizes of babbitted and bronze-bushed bearing takeups, for commercial shafting up to 5 15/16 in. diam. Series AS 2600Z bronze bearing takeups (A) are suitable for use on conveyors or elevators where service

is moderate. They can be mounted vertically or horizontally on sides of casing or on supports. Frames of pressed steel assure maximum strength with minimum weight. Bearing blocks are mounted perpendicular to base of frame. Series BS 2700Z bronze bearing takeups (B) have bearing blocks mounted parallel to base of frames. They are used on moderate-duty conveyors or elevators and are usually mounted on structural supports. Series N 3000Z bronze bearing takeups (C) are adaptable for use on moderate-duty chain or belt conveyors or other special equipment. Rigid, compact, welded - channel



frames protect screws and provide ample strength with minimum weight. Design allows maximum possible adjustment within limited installation space. **Link-Belt Co.**, Prudential Plaza, Chicago 1, Ill. J

Circle 689 on Page 19

Linear Actuator

has ram operating at 0.3 to 0.6 ips

Linear actuator provides load capacities of 100 lb tension to 600 lb compression with little change in ram speed. Ram operates at speed of 0.3 to 0.6 ips, and position-indicating potentiometer transmits ram position signals accurately to 0.001 in. Mechanically operated switches limit ram travel to maximum 1.65-in. stroke, and switches can be adjusted for shorter strokes. Potentiometer resistance is 10,000 ohms, ±5 per cent for 1.65-in. stroke. Unit has either reversible shunt or series windings, or a combination of both, to regulate speed and provide high torque outputs for heavy loads. Actuator operates on 25-29 v dc, and maximum current is 12 amp.

Explore new areas at IBM in

MECHANICS

At IBM, engineers are applying the principles of mechanics in radically new ways in order to keep pace with recent scientific advances. One project, for example, involves the design of mechanical and electromechanical devices and servos in the 5-10 millisecond range that will insure minimum noise, vibration and wear. In another project, new concepts of magnetic recording systems are being sought that will enable great quantities of data to be stored in highly miniaturized "memory" devices. Careers are available in such areas as acoustics, applied mathematics, electromechanics, servo mechanisms, systems design and vibration and wear control. For assignments like these, IBM is seeking engineers who can solve the unusual mechanics problems posed by recent technological break-throughs

You will enjoy unusual professional freedom and the support of a wealth of systems knowledge. Comprehensive education programs are available plus the assistance of specialists of many disciplines. Working independently or with a small team, your individual contributions are quickly recognized and rewarded. This is a unique opportunity for a career with a company that has an outstanding growth record.

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Mr. R. E. Rodgers, Dept. 590J
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INTERNATIONAL BUSINESS MACHINES CORPORATION

Circle 531 on Page 19

"Inspect the product-improving, cost-cutting metal-like properties of new DELRIN®"

National can now furnish extrusions or fabricated parts of this remarkable new Du Pont thermoplastic

If you have not yet evaluated this exciting new material you will want to. Exhaustive tests show that "Delrin" can compete on a cost and performance basis with parts made of many metals, rubber, glass or wood. It may be the *one best material* to solve a current problem for you.

In adding "Delrin" to its family of thermoplastics, National continues the policy of offering the designer industry's widest selection of basic materials—over 100 types and grades. "Delrin" is available in extruded rod, strip, and special shapes, or in precision fabricated parts to your design. You can depend on National's production experience for sound help on "Delrin" applications.

Sizes now available include: rod—¼″ to 2″ diameter; strip—.020″ through .093″ thick, up to 7″ wide.

Special extruded shapes available upon request. Fabricated "Delrin" parts now being furnished National's customers indicate broad application wherever strength, rigidity and dimensional stability are important.

For specific information, prices and personal assistance on the use of "Delrin"—or any of the more than 100 National materials—write National Vulcanized Fibre Co., Dept. G-10, Wilmington, Delaware. Or contact your nearby National Sales Office.

1. Extruded strip. 2. Slit-to-width strip. 3. Extruded rod. 4. Machined pulleys. 5. Punched terminal bases. 6. Bushings. 7. Terminal plugs. 8. Punched discs. 9. Punched washers. 10. Parts made in automatic screw machines. 11. Machined bolts.

CHOOSE FROM THESE MATERIALS...

Vulcanized Fibre: 10 standard grades; many special grades.

PHENOLITE® Laminated Plastic: over 80 standard and modified grades; paper, cotton fabric, nylon, asbestos, glass fabric, cotton and glass mat bases; phenolic, melamine, polyester, epoxy, teflon or silicone resins.

PEERLESS Electrical Insulation: coil, strip, corrugated.

Extruded Nylon, "Delrin", "Penton": rod, strip, tubing, special shapes.

Polyester Glass Mat: 4 standard sheet grades; custom molded shapes.

PHENOLITE Copper-Clad Laminates: 10 standard grades.

Combination Materials: Rubber-PHENOLITE; Rubber-Fibre; Wood-Fibre; Metal-Fibre; Asbestos-Fibre; PEERLESS-PHENOLITE.

BACKED BY THESE SERVICES...

Field Application Assistance
Complete Fabricated Parts Service
Stock Program for Immediate Shipment

BY CALLING THESE OFFICES..

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Cleveland	ERieview 1-0240
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Griffin, Ga.	8-1308
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Milwaukee	BRoadway 6-6995
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Newark	MItchell 2-6090
New York	COrtlandt 7-3895
Philadelphia	SHerwood 8-0760
Pittsburgh	FAirfax 1-3939
Rochester	Hillside 5-0900
St. Louis	PArkview 5-9577
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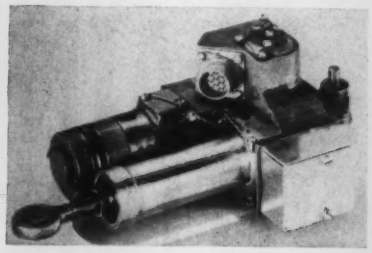
NATIONAL VULCANIZED FIBRE CO.

WILMINGTON 99, DELAWARE

In Canada:
NATIONAL FIBRE COMPANY OF CANADA, LTD., Toronto 3, Ontario



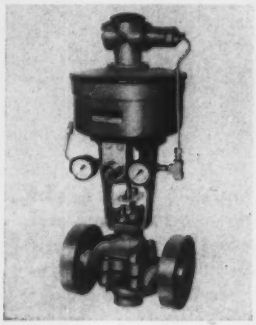
Weighing 3 lb, unit is designed for intermittent-duty operation in custom applications. **Hydro-Aire Co.**, 3000 Winona Ave., Burbank, Calif. L

Circle 690 on Page 19

Control Valves

have ductile-iron bodies

Series LB control valves and Series LM handwheel valves are available in straight-through design in ¾ through 6-in. sizes, with 150-300 lb ASA raised-face integral flanges. Valves are now furnished with ductile-iron bodies with corrosion resistance of gray cast iron and ductility and strength approaching that



of carbon steel. Valves are still available in steel, bronze, and other castable alloys. **Conoflow Corp.**, Dept. D-8, 2100 Arch St., Philadelphia 3, Pa. E

Circle 691 on Page 19

Motor-Starting Relay

for single-phase ac appliances

Klixon 6409 Series heavy-duty, current-type motor-starting relay has typical applications on motors for garbage disposers, dishwashers, clothes dryers, clothes washers, oil burners, submersible pumps, and other stationary equipment having starting loads over 10 amp. For

MB

vibration isolators

give more mount "mileage"

MB ISOMODE® mounts break endurance records. Despite heat, road shock and hard operating conditions in bus service, engine mounts removed for critical inspection after 132,000 miles were still good. To such durability add the superior vibration isolation afforded by a mount that controls vibratory motion in all directions.

MB concentrates on standard mounts which are actually in the special performance class. If you have a problem, avail yourself of our 20 years of experience. Send for Bulletin 616A which tells more.

MB ELECTRONICS

A DIVISION OF TEXTRON ELECTRONICS, INC.

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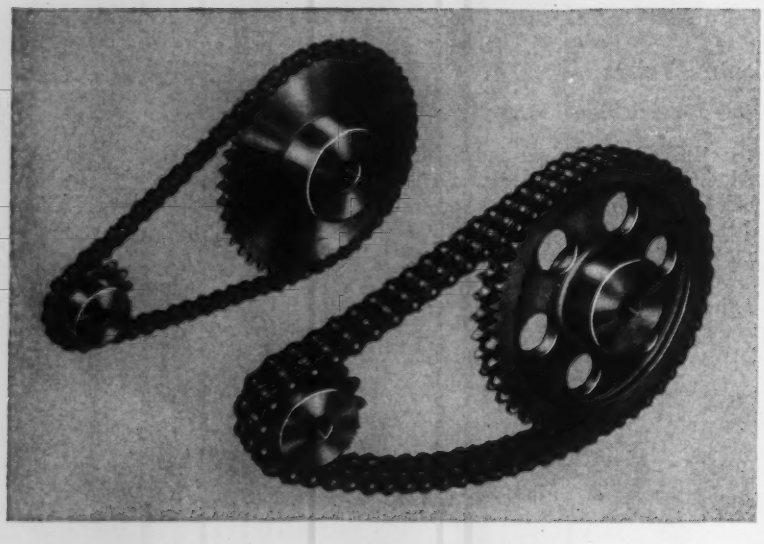
Circle 533 on Page 19

DO YOU HAVE THE PROPER CHAIN SELECTION FOR YOUR EQUIPMENT?



If there is a question in your mind about the correct size of chain to use for your particular installation, save time and money by consulting ACME Engineers at once. They will assist you in selecting the proper chain drive. In many instances, this depends on how much horsepower you want to transmit . . . the speed and size of your shaft . . . space limitations . . . hours of continuous operations, etc.

These are problems on which our engineers can draw from their many years experience to give you the correct answers.

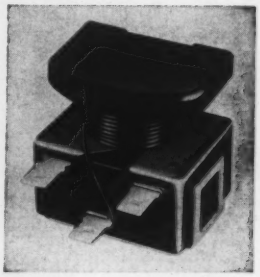
Consult your nearest ACME Distributor or write our Engineering Department for the answer to your CHAINING PROBLEMS.

Write Dept. 6-A for new 100-page illustrated technical catalog including new engineering section showing 36 methods of chain adjustments.

Acme Chain Corporation
HOLYOKE MASSACHUSETTS

COMPLETE LINE OF ROLLER CHAINS AND SPROCKETS • DOUBLE PITCH CONVEYOR CHAINS • STAINLESS STEEL CHAINS • CABLE CHAINS • FLEXIBLE COUPLINGS • STANDARD AND SPECIAL ATTACHMENTS

Circle 534 on Page 19



single-phase, ac appliances, all-welded relay has steel armature centered in solenoid-coil field, and has a bridging-type contact arm pushed into closed position by armature movement. Phenolic case fully encloses armature, switching element, and contacts. Silver-cadmium oxide contacts provide long contact and relay life, up to 1 million cycles at 5 amp, 230 v, or 10 amp, 115 v. **Metals & Controls Div., Texas Instruments Inc.**, 34 Forest St., Attleboro, Mass. B

Circle 692 on Page 19

Miniature Gear Motor

has output shaft speed of 7000 rpm

Model 70DC1R70 gear motor is a 1-hp unit which is less than 2½ in. in diam. Miniaturized unit requires 28 v dc at 65 amp. Output speed can be varied to meet specific requirements. Model illustrated has

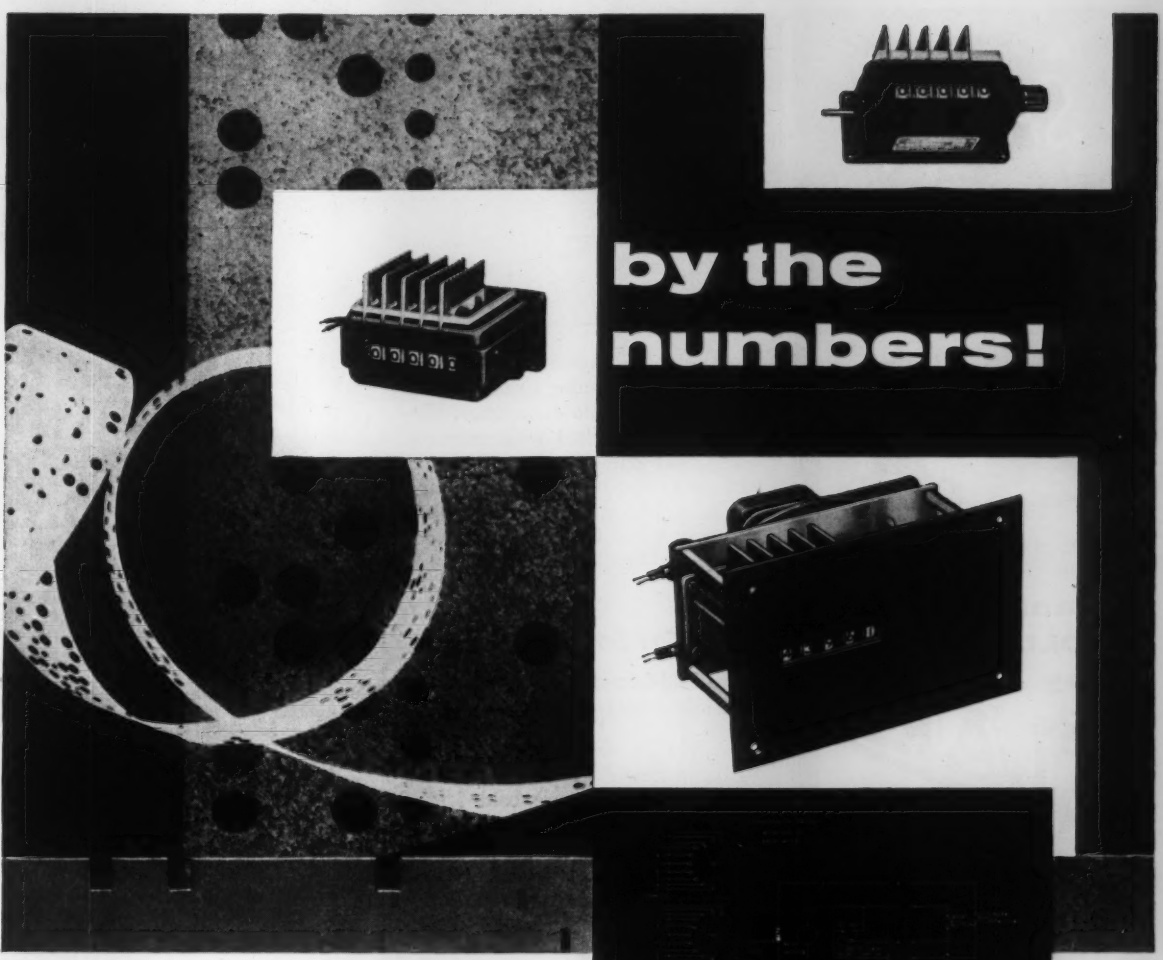
output shaft speed of 7000 rpm. **Electro Products Div., Western Gear Corp.**, 132 W. Colorado Blvd., Pasadena, Calif. L

Circle 693 on Page 19

Panel Meter

6-in. unit has wide range of scales

Clear-plastic dc general-purpose panel meter, No. 600 PI, is an economy-priced unit with wide range of scales available to meet specific requirements. The 6-in. unit has meter case of durable styrene plastic that provides clarity and easy



Remote Readout Counters Simplify Automatic Data Processing

How these counters work: Data Readout Counters are actuated mechanically by rotation of a shaft or electrically by making and breaking a circuit. Each wheel has a printed circuit, with a contact for each digit. Remote Data Readout Counters are available with manual or electrical reset, and for base or panel mounting. Standard Models are available from stock.

Now . . . Veeder-Root Remote Data Readout Counters can provide a low-cost method of collecting and feeding important information . . . by transmitting counter readings electrically.

Counter readings can be fed directly onto a punched card or tape, and into adding machines or any other data handling devices. The counter can actuate alarms or control machines to predetermined settings. And they can be arranged for automatic reset and recycling. External circuits can be designed to transmit totals in binary code, international code or in digital form.

Remote Data Readout gives you many unusual opportunities to put *Count*rol to work. Automatic processing of machine production, and shaft rotation, remote digital readout, centralized control, simplified automation, and printing and computing applications are just some of the intriguing possibilities available with remote data readout.

Send for Veeder-Root Technical Information . . . Complete specifications on Remote Data Readout Counters will be sent at once; and application assistance is available if desired.

Veeder-Root Inc.
HARTFORD 2, CONNECTICUT
"The Name that Counts"
Hartford, Conn. • Greenville, S. C. • Altoona, Pa. • Chicago
New York • Los Angeles • San Francisco • Seattle • St. Louis • Montreal
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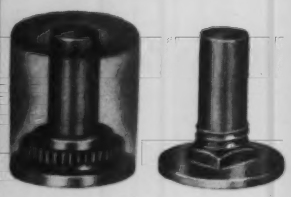
V59-57

Circle 535 on Page 19

A SAVING OF OVER $40.00
per thousand pieces



MILLED FROM BAR COLD HEADED

thanks to COLD HEADING by CLARK

THE PROBLEM:
Cut costs on a special fastener blank used as insert in plastic knob.

SPECIAL REQUIREMENTS:
Fastener must have surfaces that grip into plastic and hold fast when knob is pulled laterally or turned.

SOLUTION:
Redesign to simplify gripping surfaces. Production by Clark Cold Heading process (instead of machining from bar stock).

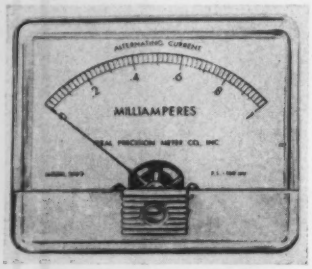
SAVINGS:
In steel ....$19.70 per 1 M pcs.
In labor, over 21.00 per 1 M pcs.
TOTAL, over $40.00 per 1 M pcs.

It's quite possible that Clark Cold Heading can effect equally impressive savings on *your* special fasteners.

Send sample (or blueprint) for prompt analysis and quotation ... *at no obligation.*

CLARK BROS. BOLT CO.
MILLDALE, CONN.

Circle 536 on Page 19



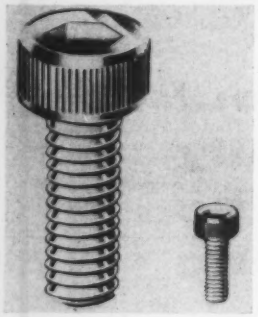
readability. D'Arsonval movement guarantees minimum accuracy of 2 per cent (full scale deflection). Meter can be furnished with mirrored scales that eliminate parallax, and with any type of pointer including spade, lance, and knife edge. **Ideal Precision Meter Co. Inc.**, 126 Greenpoint Ave., Brooklyn 22, N. Y. D

Circle 694 on Page 19

Socket Cap Screws

are cold-forged stainless steel

Available in sizes from No. 6 to 5/8 in. in new ASA 60 or old series, socket cap screws are cold forged of stainless steel. They can be reapplied many times, and take high tightening torques. Clean, chip-free sockets provide easy, rapid driv-



ing, and rolled threads allow perfect fit. **Set Screw & Mfg. Co.**, Bartlett, Ill. I

Circle 695 on Page 19

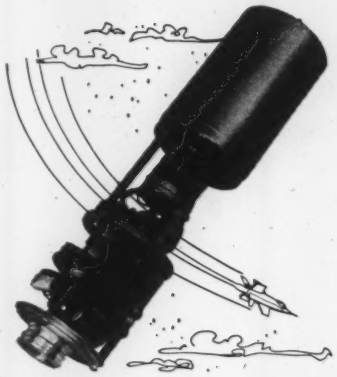
Pulse Counter

is activated by stepping motor

Low-torque pulse counter, designated Model 2010, is activated by a stepping motor. Counter drums can be turned flawlessly up to 40 counts per sec. Standard model has six drums, but unit is also avail-

SPECTROL PRECISION MECHANISMS

Pilot to Cockpit to Control



When a test pilot rockets into the outer atmosphere for the first time driving experimental craft such as North American's X-15, he'll feel as though he's been there before.

Before his first actual flight, the pilot trains for many hours in "dry land" rocket craft. There, he learns to cope with upper atmosphere problems as posed by an analog computer. Every time he touches a control, the computer responds and the result appears on the instrument panel in the training cockpit. The entire bank of instruments reacts as though he were really "up there." In this way, the pilot meets every conceivable situation long before he takes his powerful bird aloft.

And what does Spectrol have to do with this important training program?

Spectrol makes the link that joins the computer and the bank of instruments in the cockpit. This link, known as a servo repeater, translates the computer's information into meaningful dial readings. As you know, such information must be transferred quickly and accurately.

Spectrol servo repeaters do just that. Key specifications for a typical unit now in production are:

Maximum velocity: 360°/sec
Acceleration in excess of 7000°/sec²
Static accuracy better than 0.25 deg. at output shaft

Other applications for Spectrol packaged servo repeaters include dial drives on GCA equipment, airborne computers and dc systems in general.

Spectrol PRECISION MECHANISMS free the systems engineer from building functional sub-assemblies. If you need precise logical system modules combining in a *single specification* sub-assemblies using components such as gear drives, clutches, precision potentiometers and servomotors —Spectrol can help.

For complete information, call your nearest Spectrol engineering sales representative, or address Dept. 5710

14

SPECTROL
ELECTRONICS CORPORATION
1704 SOUTH DEL MAR AVENUE • SAN GABRIEL, CALIF.

Circle 537 on Page 19

Fawick Clutches here...

Chase Brass and Copper Co. drawbench uses FAWICK DUAL VENTORQUE CLUTCH which provides large torque capacity, controlled slippage, and cool-running operation from ventilated construction.

provide smooth acceleration, full power HERE!

Record size of this Chase drawbench, which draws up to 6-inch tube to 210 feet, demands extra-smooth operation. FAWICK VENTORQUE CLUTCH assures shock-free starts and steady acceleration of bench carriage to prevent tube binding or irregularities.

The drawing of smooth-surfaced, accurate dimension tubing requires controlled acceleration at the start of the draw and steady, full-power pull through the drawing cycle.

This is accomplished on the world's largest drawbench at the Euclid plant of Chase Brass and Copper Company, by smooth transmission of power from a 500 h.p. motor and speed reducer to the bench mechanism through a FAWICK 20VC600 Dual Ventorque Clutch. This bench, built by Aetna Standard Manufacturing Company draws continuous tubing to 210 feet long in sizes ranging to 6 inches in diameter.

The draw starts with simultaneous engagement of the clutch and hooking of the draw carriage to the driving chains. Gradual acceleration is accomplished through controlled slippage of the clutch while bringing the carriage to full drawing speed. This is done with a flow control valve which gradually increases the air pressure in the clutch and results in smooth, yet positive acceleration of the chain and carriage.

This is typical of many installations where the inherent advantages of FAWICK Clutches provide top-performance answers to power-transmission problems.

For full details on FAWICK power-transmission products call or write your nearest FAWICK representative or the Home Office, Cleveland, Ohio.

Circle 538 on Page 19

FAWICK AIRFLEX DIVISION
FAWICK CORPORATION
9919 CLINTON ROAD • CLEVELAND 11, OHIO
Fawick Canada, Ltd., 60 Front St., West, Toronto, Ont., Canada

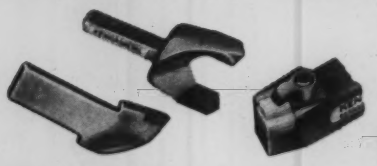
FAWICK AIRFLEX

INDUSTRIAL CLUTCHES AND BRAKES

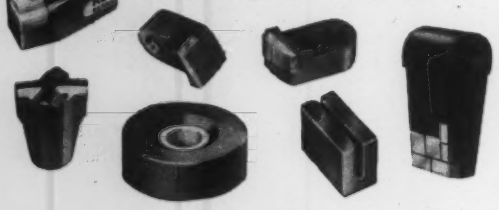
No doubt about it...
Reliability is a most important characteristic of KENNAMETAL*

Exceptional characteristics of Kennametal have solved varied problems in many fields. But one of the most important contributions made by Kennametal to any project is *reliable performance* . . . delivering the expected service and life under given conditions. That's why Kennametal is used more and more where it is found *or feared* that other materials just aren't good enough.

Will these *dependable* characteristics of KENNAMETAL hard carbide alloys help solve some of your problems?

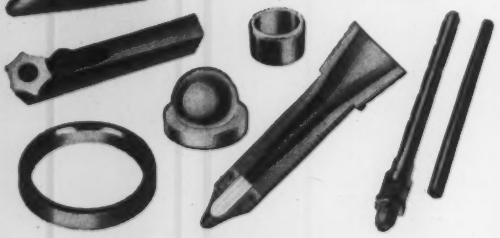


DEPENDABLE resistance to wear and impact . . . that provides long-lasting cutting tools for the mining, metalworking and woodworking industries. (Kennametal often wears up to 100 times longer than the hardest steel.)



DEPENDABLE resistance to abrasion . . . for such component parts as spray nozzles, orifices, seal rings, bushings, pulverizing hammers, drawing and compacting dies, non-lubricated guides and various gripping jaw applications.

DEPENDABLE resistance to corrosion, cavitation and wear . . . vital to valving in oil well operations, hydraulic systems, parts for chemical processing equipment exposed to strong mineral acids, red fuming nitric acid and similar highly corrosive agents.



DEPENDABLE strength at high temperatures . . . needed for gas turbine components, sensing elements for jet stream thermostatic controls, parts to handle or process glass in semi-plastic state, flame burner tips, hot rod mill guides, tip wear rings for scarfing torches. (Kentanium*, a series of hard titanium carbide alloys, retains high strength for continuous operation at temperatures up to 2200°F and provides high stiffness/weight ratio.)

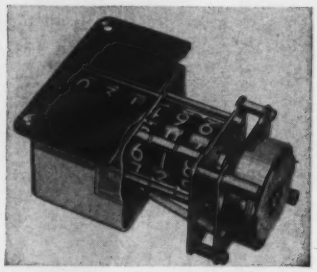
DEPENDABLE resistance to deformation . . . required by spindles for precision grinding, grooving blades, boring bars, compressor cylinder liners and components for high pressure valves. (Kennametal has a YME up to 94 million psi, 3 times that of hardest steel.)

*Trademark 97227

INDUSTRY AND **KENNAMETAL** ...Partners in Progress

For more information, send for: Booklet B-111A, "Characteristics of Kennametal," Booklet B-222, "Designing with Kennametal," Booklet B-444A, "Kentanium."

Write to KENNAMETAL INC., Department MD, Latrobe, Pa.



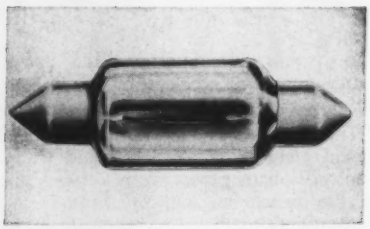
able in two, three, four, and five-drum types. Planetary drive transfers numbers by activating a nylon cam and roller compensating device, moving planetary gears which are always in mesh. Large, 5/16-in. numbers are used for easy, direct reading. **Haydon Instrument Co.**, Waterbury 20, Conn. B

Circle 696 on Page 19

Cartridge Lamps

are festoon-type units

No. 211 and 212 lamps are festoon-type cartridge units with primary application in automotive dome and courtesy lights, radio and other panel lamps, and in license-plate illumination. Both are 12.8-v, 1.02-amp lamps with light output of 16 and 6 cp respectively. Externally similar, each is rated for 100 hr continuous operation, is 1¾ in. long, and has bulb diam of 0.6 in. Single-coil straight-line filament



stretches ½ in. between supports anchored to each end to provide maximum possible ratio of applied voltage to light output. **Tung-Sol Electric Inc.**, Dept. A, 1 Summer Ave., Newark 4, N. J. D

Circle 697 on Page 19

Toggle Switch

improves panel appearance

Toggle switch incorporates a chrome-plated handle with squared-off corners and flat sides. Highly polished jam nut fastens 15/32-in.

The new LICON® line . . . precision switches for every need

In the new, broadened Licon line you'll find every switch designed to meet modern high capacity, long life requirements. These are switches built to do today's tough jobs. Typical is the unique Type 16—heart of many Licon switch assemblies—tiny in size but rugged enough to handle big switch loads with unbelievable life. Check the unusual "specs" of the Type 16, and all Licon types, against your switch needs—see and compare Licon life against any switch—we're sure you'll specify Licon. *Send for catalog on new broad* **Licon** *line*

—Gives handy dimensional data and engineering specifications you'll want to keep for ready reference.

Type 30 Enclosed Limit Switches—Interchangeable components form up to 16 switch types for [illegible] compact, low-priced. 15A., 125V a-c—for industrial applications.

H—Hermetically sealed Switches—Designed for dependability in extreme environments. Unique, [illegible] moisture and other elements. Designed especially to your application.

Type 14 Heavy-duty Switch—Built for heavy industrial and machine tool service. Rugged snap-[illegible] amps at 250V a-c.

Type 10 Long-life Basic Switch—New Serpentine action mechanism delivers 10 million operations [illegible] with movement differentials as low as .0005". Rated 15 amps.

Type 22 Double-pole, Double-throw Switches—Provide positive control of four independent [illegible] applications—withstands 25G at 2000 cps. Rated [illegible] a-c (res.).

P—Panel mounted Switches—Variety of types—to 8 or more poles—some solenoid reset or mag-[illegible] as required.

Type 11 Snap-action Switches—Resist 50G vibration to 2000 cps. Double-break, snap-action [illegible] contact welding and provides greater capacity. Rated 10 amps., [illegible]

Type 16 Subminiature Switches—Here's big-switch performance in a tiny unit. Only ¼" thick, [illegible] d-c ind. Greatest shock- and vibration-resistance of any switch in its class on the market . . . even near trip point.

LICON

Available through your local Licon distributor.

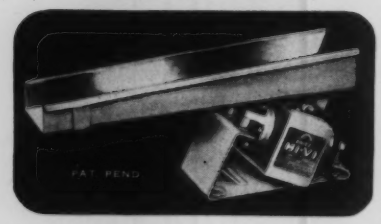
DIVISION OF ILLINOIS TOOL WORKS

6606 W. Dakin Street, Chicago 34, Illinois

i t w

Circle 540 on Page 19

FEEDER
OF THE future
HERE NOW!
electro-permanent magnetic
ERIEZ
HI-VI
VIBRATORY
FEEDER



Award-winning feeder . . . features new concepts in design and use of materials. Priced right; provides superior performance; lower operating costs; reduced maintenance and greater production output! For *automatic*, accurate feeding of all types of bulk materials. Variable feed rate from ounces to tons . . . performs spreading, aerating, cooling, proportioning, screening, other operations.

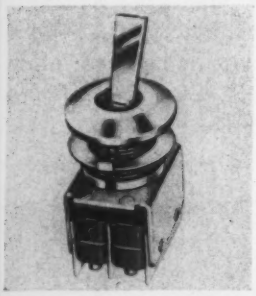
NEW A.C. ELECTRO-PERMANENT MAGNETIC DRIVE PROVIDES GREATER FEEDING CAPACITY • NO RECTIFIER NEEDED • FULLY ENCLOSED POWER ELEMENT PROTECTED AGAINST DUST AND MOISTURE • RUGGED GLASS FIBER SPRINGS REDUCE BREAKAGE • FULLY PROVED IN PLANTS EVERYWHERE

ALSO AVAILABLE: Economical, specially constructed units for hazardous, dusty locations . . . fully acceptable by Mill Mutual.

WRITE FOR BIG VIBRATORY FACT FILE
Eriez Mfg. Co., 131-XB Magnet Dr., Erie, Pa.

ERIEZ

Circle 541 on Page 19



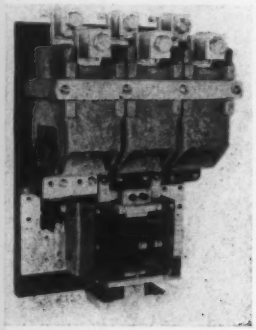
bushing to panel. Unit is for use in control panels where appearance is important. Design permits greater travel of bat handle than that on other toggles, and gives positive feel when switch is thrown. Switch is available in double-pole, double-throw and triple-pole, double-throw versions. Each individual circuit is rated 5 amp at 125 v ac, 4 amp at 30 v dc resistive, and 2.5 amp at 30 v dc inductive. **Electrosnap Corp.**, 4218 W. Lake St., Chicago 24, Ill. J

Circle 698 on Page 19

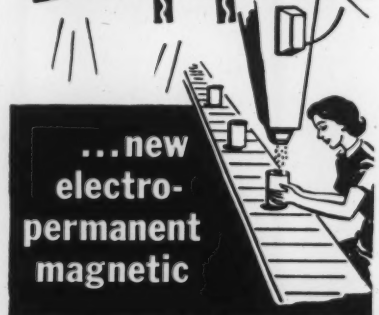
Solenoid Contactor

for use in motor starters and controllers

NEMA Size 5, 300-amp solenoid contactor provides long life, simple solenoid design, and exceptional compactness. Designed primarily for use in motor starters and controllers, it is also recommended for heater and lamp-load switching. Heavy inrush currents are handled by double-break contacts, enclosed in individual arc hoods. Fully accessible normally open, normally closed, or low-power auxiliary contacts are available. Pressure-type connectors are supplied for all control wiring, and clamp-type terminals are standard on main poles. Standard coil voltages are 110,



Hopper Bopper



. . . new electro-permanent magnetic
ERIEZ
HI-VI
BIN VIBRATORS

Here's the newest and most efficient answer to those hard-to-move materials in sticky bins . . . designed to provide superior operating efficiency . . . exclusive pinpointed vibration gets right to the trouble spot—starts stubborn materials moving!

NO RECTIFIER NEEDED • JUST PLUG OR WIRE INTO A.C. LINE • COMPLETELY ENCLOSED HOUSING ASSURES LONG TROUBLE-FREE LIFE • GREATER VIBRATION IMPACT THAN COMPARABLE SIZE UNITS • LOW FIRST COST • LOW OPERATING, MAINTENANCE COST.

Also available: Special Mill Mutual ACCEPTED Units for HAZARDOUS DUSTY LOCATIONS.

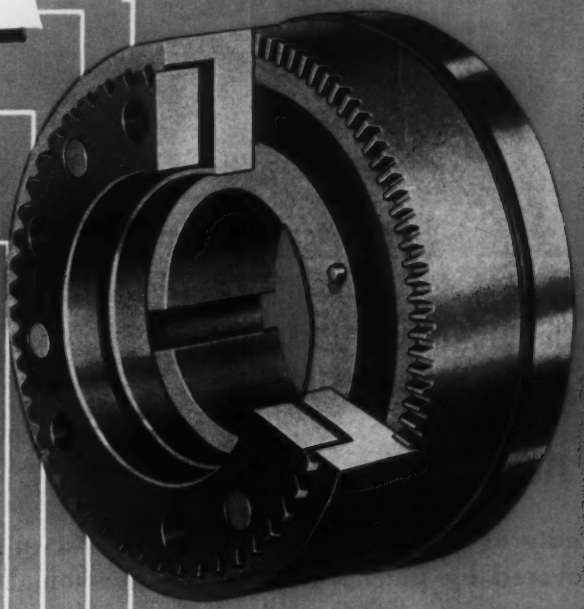
GET BIG VIBRATORY FACT FILE . . . WRITE TODAY.
Eriez Mfg. Co., 131-XA Magnet Dr., Erie, Pa.

UNSTICK STUCK BINS
ERIEZ

Circle 542 on Page 19

IDEA— for your power transmission file—

Elmag Electro-Magnetic Tooth Clutch



Pat. Pending

Full-size outline drawings
Can be used for tracing

Clutch EZE 40
EZE 75
EZE 150
EZE 300
EZE 600
EZE 1200
EZE 2000
EZE 4000

- Extremely high torque transmission with reference to overall dimensions.
- Absolutely no idle torque.
- Engagement up to 300 RPM relative speed.
- Disengagement under full load while running at maximum RPM.
- Bolt-on design accomplished through a simple mounting adapter.
- Clutches available from stock with torque ratings from 40 to 4000 ft. lbs.

For complete information and specifications send for your free copy of Elmag Electro-Magnetic Tooth Clutch Bulletin No. 358.

ELMAG
CLUTCH AND BRAKE DIVISION
McCAULEY INDUSTRIAL CORPORATION
1840 HOWELL AVENUE • DAYTON 17, OHIO
TELEPHONE: AMherst 3-3541

ROCKFORD

Small Spring Loaded

Automotive Spring Loaded

Heavy Duty Spring Loaded

Oil or Dry Multiple Disc

Heavy Duty Over Center

Light Over Center

Power Take-Offs

Speed Reducers

Genuine ROCKFORD Features Are Patented

Features of the ROCKFORD RT CLUTCH are covered by patents and patents pending. To give your product the full advantages of these ROCKFORD developments, it is necessary to specify ROCKFORD CLUTCHES.

Don't be fooled by any "copy" or "imitation." The Genuine ROCKFORD CLUTCH is what YOU want. The ROCKFORD CLUTCH has the needed skill and long years of experience behind it.

Let our engineers help you determine the type and size clutch best suited to help improve the power transmission control in your next model.

SEND FOR THIS HANDY BULLETIN

Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

ROCKFORD Clutch Division BORG-WARNER

311 Catherine St., Rockford, Ill., U.S.A.

Export Sales Borg-Warner International — 36 So. Wabash, Chicago 3, Ill.

ROCKFORD B-W BORG-WARNER

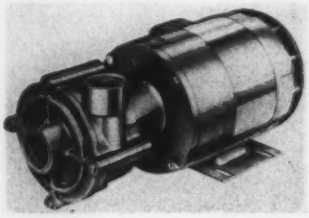
CLUTCHES

208/220, 440, and 550 v, 60 cycles. Basic contactor is 10½ in. wide, 17⅜ in. high, 3 in. deep. **Ward Leonard Electric Co.**, Mt. Vernon, N. Y. D

Circle 699 on Page 19

Centrifugal Pump

for use with corrosive liquids



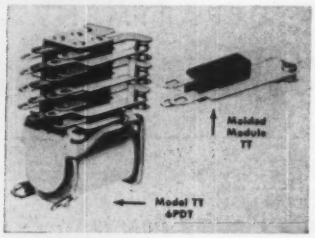
Centrifugal pump for continuous duty with certain chemicals and other corrosive liquids has 1-in. outlet. It delivers up to 33 gpm at pressures to 28 ft of head. Body, face plates, and impeller are chemical-resistant plastic, or, on special order, any material that can be injection molded. Shaft and couplings are Type 316 stainless steel, and O-ring is neoprene. Motor, encased in aluminum, is either single or three phase. Rotary mechanical seal provides excellent, permanent, low-drip sealing that requires no adjustment or maintenance. Simple, compact design, light weight, and easy maintenance adapt pump for use on a variety of equipment. **Houston Fearless Corp.**, 11819 W. Olympic Blvd., Los Angeles 64, Calif. L

Circle 700 on Page 19

Small Relays

have high sensitivity

Designed to meet military requirements of MIL-R-5757C and MIL-R-6106C, Model TT and TS relays have standard contact-spring combinations molded into integral units or modules. Modules assure unvarying alignment, permanence of adjustment of mating contact springs, and accurate alignment of modules on relay. High sensitivity, small size, and high ambient operation are also features of the relays. They can be furnished to operate in ambients to 125 C. Model TS relay is larger than Model TT and



transfers heavier currents. Both are ideal for rigorous duty in commercial or military aircraft. **Ohmite Mfg. Co.**, 3646 Howard St., Skokie, Ill. J

Circle 701 on Page 19

Solenoid Valves

are now available in 1 and 1¼-in. pipe sizes

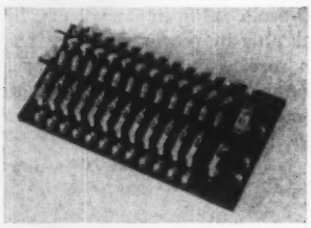
Nopak-matic valves in two new standard pipe sizes are furnished in master, single, and double-solenoid body types. The 1 and 1¼-in. valves have extremely large body orifices, free from obstructions, and capable of passing a large volume of air or hydraulic fluids. They are recommended for the fast cycling of large-bore cylinders. **Nopak Div., Galland-Henning Mfg. Co.**, 2753 S. 31st St., Milwaukee 46, Wis. K

Circle 702 on Page 19

AC Relays

have up to 24 poles

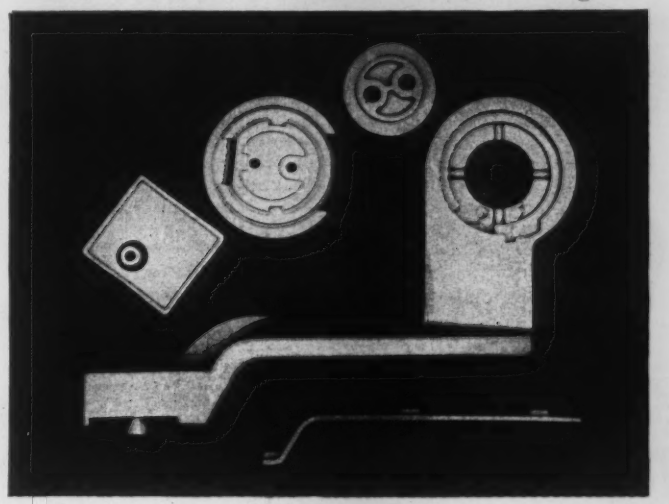
Mechanically held ac relays are rated 25 amp per pole, noninductive load. They are now available with up to 24 poles. Increased number of poles permits wider utilization of the units as primary relay devices controlling contactors, sole-



noid valves, and similar equipment, or as branch circuit devices directly controlling electric ovens and furnaces, lights, and other loads within their capacity. **Automatic Switch Co.**, Florham Park, N. J. D

Circle 703 on Page 19

POLAROID specified dimensional accuracy

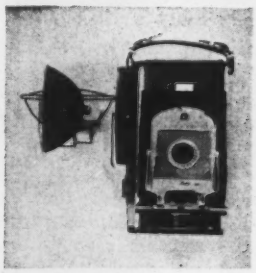


and got it from CONSOLIDATED

Both dimensional accuracy and fine appearance were essential requirements in the production of this camera flash attachment for Polaroid. Naturally, mold planning and construction were of utmost importance in such a critical job. Precision and timing had to be built into the mold design Three different molds were necessary to produce the five separate pieces which form one synchronized unit.

In assembling the unit, all parts had to be kept in perfect alignment; no warpage or twist was permitted. For appearance's sake, it was necessary to locate mold parting lines on the natural edges of the pieces.

This flash attachment unit represents the type of molding challenge Consolidated welcomes. We appreciate the opportunity to quote on any molding – complicated or simple.



The Polaroid Bounce Flash Bracket (Model #292), with swivel-type flash gun clip, permits the taking of both horizontal and vertical pictures without removing the gun to change its position.

For more than 80 years we have been filling exacting plastics orders for the nation's blue chip companies. Before you discard any design you feel can't be molded in a plastic, call Consolidated.

CMP

"Your Blueprint in Plastics" Since 1874

CONSOLIDATED MOLDED PRODUCTS CORPORATION

335 Cherry St., Scranton 2, Penna.

Send for your free copy of our new 20-page Facilities Report.

Moccasin BRONZE SLEEVE BEARINGS

TIME TO RE-EXAMINE BEARING APPLICATIONS

Take advantage of new design information. Re-examine your designs to reduce costs—initial, installation, maintenance and replacement. Take a new look at old bearing designs to increase life, eliminate noise or corrosion problems and reduce power losses in bearings. Moccasin engineers will gladly help...make recommendations to create better bearings...and make sure that the bearing is one that can be produced economically.

MOCCASIN PRODUCES THE FOLLOWING:

Special sizes of cast bronze sleeve bearings. All sizes up to 48" diameter and 1000 pounds. A complete line of 13" machined bronze bars. All bronze bearing alloys stocked and available. Centrifugal, permanent mold and sand casting facilities. All types of half and split bearings—self-aligning bearings—thrust washers—segment bearings. Gear blanks furnished in the rough or machined ready for hobbing. Rough castings for any bearing parts. Graphited bearings made in various styles. Moccasin Oil Distributing Bearings. All bearings and parts unconditionally guaranteed.

MOCCASIN BUSHING CO.

"Quality Bronze Since 1908"

MEMBER OF CAST BRONZE BEARING INSTITUTE

2000 Chestnut Street • Phone AM 7-9554

CHATTANOOGA 8, TENNESSEE

Circle 546 on Page 19

IMPORTANT MEMO

TO: SENIOR ANALYTICAL & DESIGN ENGINEERS • DESIGNERS • DESIGN CHECKERS

FROM: BABCOCK & WILCOX

RE: CREATIVE, CHALLENGING, GROWTH OPPORTUNITY

IF YOU are ready to step into an already big job... to help it grow... and to grow with it, you may well be one of the men we are seeking.

WE WANT senior analytical and design engineers, designers, and design checkers... men of vision and imagination... to develop fuel elements, control rod drive systems, reactor internals, remote handling and maintenance equipment for nuclear reactors. Nuclear experience is *not* a necessity... an inquisitive interest *is*.

WE OFFER a well-paying opportunity to work with some of the finest... and most experienced... minds in the field. As a company, we've been successfully engaged in pioneering nuclear developments from the very inception of atomic energy. Located in the heart of Virginia's beautiful Blue Ridge country, we enjoy pleasant suburban living... and think you will, too.

FOR INFORMATION *write to:*

W. F. Porter, Personnel Manager
THE BABCOCK & WILCOX COMPANY
Atomic Energy Division
1201 Kemper Street • Lynchburg, Virginia

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PE-31-AE ***ATOMIC ENERGY DIVISION***

Complete nuclear systems, cores, components, fuel elements, nuclear research and development

Circle 547 on Page 19

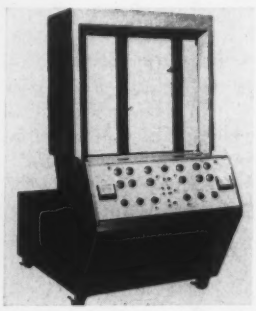
ENGINEERING DEPARTMENT

EQUIPMENT

Data Plotting Boards

take variety of dc analog signal inputs

Two analog data plotting boards, MC-3301 and MC-3302, plot one dc analog signal or two signals simultaneously on 30 x 30-in. surface. Model MC-3301 is equipped with one arm-pen assembly and Model MC-3302 with two. Completely transistorized plotting boards consist of plotting assembly and control panel. They can be utilized with plotting surface in any position desired from horizontal to vertical. Control panel can be located adjacent to plotting surface or on a remote control desk or console. Electroluminescent back illumination for plotted data is completely diffused, glarefree, without fluorescent noise. Plotting surface is available in multiples of standard 30 x 30-in. board. Equipped with 400-cycle, plug-in servo amplifiers and plug-in power supplies, boards can receive input from two or four channels of analog input data. **Computer Systems Inc.**, 611 Broadway, New York 12, N. Y. D



Circle 704 on Page 19

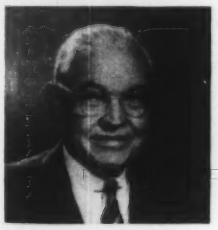
Servomechanism Kit

contains over 274 pieces

Model 20-200 servomechanism kit provides for assembly of a variety of 1⅞-in. diam electromechanical instrumentation. Kit contains over

R B&W FASTENER BRIEFS

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY



Technical-ities

By John S. Davey

The choice between a cap screw and socket head screw

If you have the choice, make it a socket screw when you have a space problem, but choose the cap screw for more holding power per dollar.

No question that you should apply socket screws in counterbored holes; and that you can clear tight spaces. What you can't do is utilize the full strength of the alloy needed for the socket head. And remember, strength of a connection depends on how you preload the fasteners, and not on the strength of the fastener material alone.

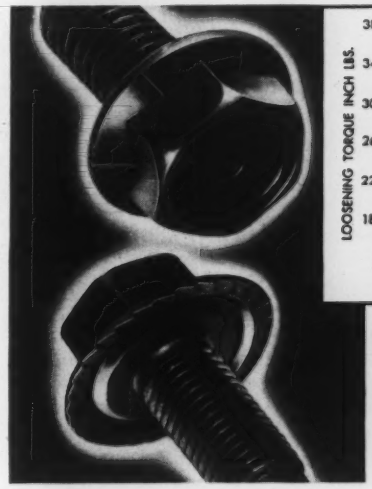
THE HANDICAPS OF ONE

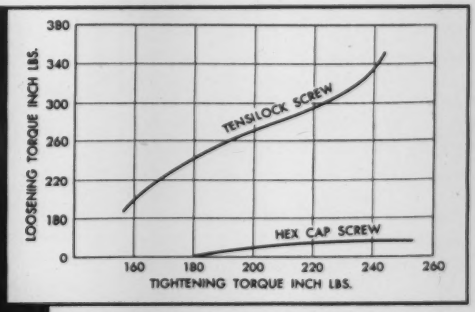
Internal wrenching rarely develops as much torque as needed for proper preloading. And if high torque is developed, the smaller bearing area of the socket head tends to crush the surface on which it bears rather than increase tension or preload.

THE ADVANTAGES OF THE OTHER

If you design to take advantage of heat treated cap screws of SAE grade 5 quality, you'll get a stronger connection at lower cost. These standard fasteners have ample bearing and wrenching surfaces, can be torqued right up to yield strength. They also cost less than the alloy fasteners.

New TENSILOCK* Screws seat tighter, lock tighter





Graph shows example of on-torque and off-torque relationship. It takes more torque to loosen than to tighten.

RB&W's new TENSILOCK screws, the toothed fasteners with high tensile locking, are identified by six radial dashes on flange.

Head has integral washer face with teeth that lock fastener to surface. Circular groove allows flange to flex and seat to bear solidly on surface.

RB&W's TENSILOCK fasteners feature ratchet-like teeth formed at an angle which cuts driving effort yet which enables the teeth to bite in firmly and give an improved grip against back-off.

In addition, a circular groove in the integral "washer" permits the flange to flex upon tightening, and helps maintain tension in the fastener and pressure on the teeth.

IMPROVED TENSION TO TORQUE RATIO

With reduced friction under the head, the new tooth design has enabled more of the wrenching torque to be used to develop tension and less to overcome friction. Since the flange flexes, it allows the screw to bear solidly on its seat. All of the high strength capabilities of these heat-treated one-piece fasteners can now be attained for a stronger assembly.

MORE LOCKING POWER

Tensilock screws need up to 40% more off-torque than on-torque. Combining this feature with the higher residual tension, and the diaphragm action of the integral washer face, these fasteners give superior locking and holding power for permanently tight, strong joints . . . even under severe vibration and cyclic temperature changes.

Now available in limited range of screw types (not in flat head), and in various nut sizes. For details, write Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, New York. *Trade Mark Pat. applied for.

Plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional sales offices at: Ardmore (Phila.), Pa., Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

Circle 548 on Page 19

MANY WRONGS MAKE OUR SLEEVE BEARINGS JUST RIGHT

The scores of design errors we have encountered in 25 years of bronze bearing production comprise one of the most valuable benefits we can offer you — *experience*. The experience to help you with design problems, to suggest a slight change which will not affect performance but will save production costs, to use the correct alloy for optimum bearing life or to provide the proper lubrication system.

It is this experience that gives us the confidence to offer the largest variety of bronze bearings available anywhere . . . a full range of sizes in both cast and sintered bearings including grooved and graphited items.

Be sure to take advantage of this specialized knowledge the next time you have a bearing problem. Let us help you avoid the pitfalls of others. We will welcome your inquiries.

See the coupon below for some information you should have in your files.

A Founding Member—
Cast Bronze Bearing Institute

RENEWAL SERVICE INC.
1703 Lehigh Ave., Phila. 32, Pa.

Send me "Chemical and Physical Specifications of the Bronze Alloys" which includes MIL., SAE, Navy, Aero., ASTM, and Fed. Spec. Comparatives.

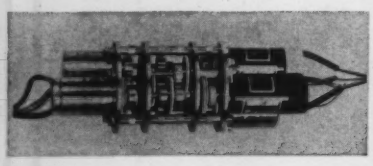
Name_____

Company_____

Address_____

Renewal Service INC.

Circle 549 on Page 19



274 pieces and provides all necessary parts to construct complete servomechanisms, indicators, and analog computing elements (shown) suitable for use in prototype or low-volume production airborne applications. Mechanisms assembled can be sealed in cases conforming to MS-33639 (ASG) and can be panel mounted, meeting environmental requirements of MIL-E-5272. **Servo Development Corp.**, 567 Main St., Westbury, L. I., N. Y. D

Circle 705 on Page 19

Epoxy Adhesives

for strain-gage applications

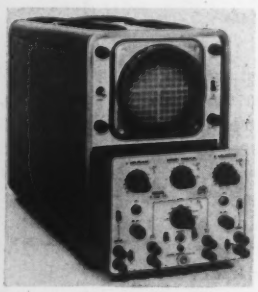
Two epoxy cements bond strain gages firmly to any test material. Designated EPY-150 and EPY-400, they have maximum service temperatures of 150 and 400 F respectively. Cements are furnished in small plastic packs, each divided into two compartments containing liquid adhesive and activator. Cement is mixed by removing split metal pin which divides pack, and kneading. **Electronics & Instrumentation Div., Baldwin-Lima-Hamilton Corp.**, 42 Fourth Ave., Waltham 54, Mass. B

Circle 706 on Page 19

Oscilloscope

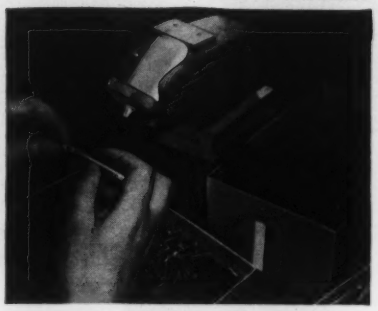
has all major circuits plugged in

Model K-160 oscilloscope has all signal-generating and processing circuitry included in a single plug-in system. Several systems are



(Advertisement)

No. 6 of a series



Eastman 910 Adhesive solves another production bottleneck

The Waterman-Bic Pen Corp., of Seymour, Conn., manufacturer of fine writing instruments, introduced recently the Jewel-Point, a high ink capacity, synthetic sapphire ball-point pen.

In designing the pen, Waterman-Bic investigated adhesives as a faster, more economical way of joining the metal nose cone to the plastic barrel.

After extensive testing, their engineers found quick-setting high-strength Eastman 910 Adhesive to be the answer, eliminating more costly threading.

In production, a drop of adhesive is placed on the end of the plastic barrel. The barrel is inserted into the brass nose cone. A quick twist to spread the adhesive... *and the bond is formed.*

Eastman 910 Adhesive is making possible faster, more economical assembly-line operations and new design approaches for many products. It is ideal where extreme speed of setting is important, or where design requirements involve joining small surfaces, complex mechanical fasteners or heat-sensitive elements.

Eastman 910 Adhesive is simple to use. No mixing, heat or pressure is required. Upon spreading into a thin film between two surfaces, setting begins immediately. With most materials, strong bonds are made in minutes.

What production or design problem can this unique adhesive solve for you?

For a trial quantity (⅓-oz.) send five dollars to Armstrong Cork Co., Industrial Adhesives Div., 9110 Dean Street, Lancaster, Pa., or to Eastman Chemical Products, Inc., Chemicals Div., Dept. M-10, Kingsport, Tenn. (Not for drug use)

Circle 550 on Page 19

Metallurgical Memo from General Electric

René 41 conical forging is 30" high, 26" O.D. at flange; forged from 510-lb. billet multiple. Offers tensile strength of over 100,000 psi at 1650° F.

How René 41* combines WORKABILITY with top strength at high temperatures

Metallurgical Products Department reports on a new vacuum-melted super alloy—and on how its unique properties make it ideal for use in everything from jets to machine components

When design specifications call for the "impossible"—*workability* combined with top strength, minimum weight, and high temperature resistance—a G-E vacuum-melted alloy may be the answer.

For example, this front conical turbine shaft for a jet engine is made as a forged, backward extrusion—requiring excellent workability. And, because of the part it plays in the functioning of the engine, high strength and resistance to supersonic temperatures (1000°-1800° F.) are musts! The solution: René 41 alloy!

Virtually free from impurities, René 41 can be successfully forged, welded, or formed; offers top tensile and stress rupture strengths, increased ductility, operational reliability. With these unique properties, René 41 is well suited to applications in machine design, as well as in jet engine components!

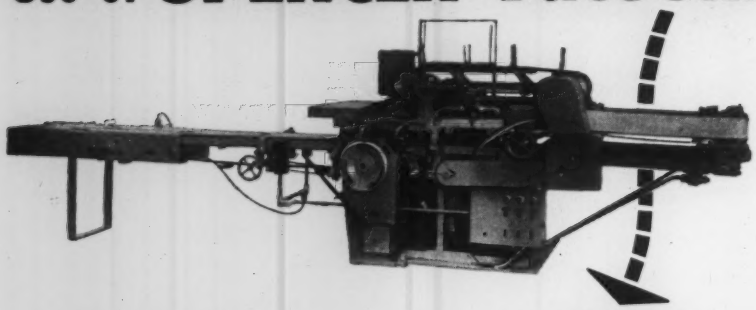
Got a design problem? Choose from General Electric's variety of high-purity, vacuum-induction-melted alloys in sheets, bars, billets, wire, or castings. For detailed information—or the assistance of one of our engineers—write today to: *Metallurgical Products Department of General Electric Company, 11159 E. 8 Mile Road, Detroit 32, Michigan.* *René 41 is a trademark of the General Electric Company.

METALLURGICAL PRODUCTS DEPARTMENT

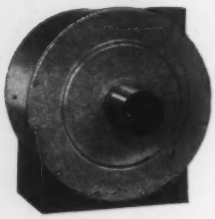
GENERAL ELECTRIC

CARBOLOY® CEMENTED CARBIDES • MAN-MADE DIAMONDS • VACUUM-MELTED ALLOYS • THERMISTORS • MAGNETIC MATERIALS • THYRITE®

Use of SPENCER Vacuum



Solved this Designer's Problem



In designing this frozen food wrapping machine, product of Package Machinery Co., the problem was to find a means of holding the easy-opening tape in proper position.

A Spencer 1/2 H.P. vacuum producer proved the answer. Vacuum holds the cellophane tape in fixed position on a perforated belt. This belt transports and applies the tape across the web feed of a wrapper (wax paper, foil or cellophane) prior to placing wrapper around the package.

If you have a design problem where vacuum might offer a solution, it will pay to check with SPENCER—manufacturers of a complete line of vacuum producers for standard or special applications.

Standard Capacities of Spencer Vacuum Producers
2 through 100 H.P.
Up to 12" Mercury Vacuum
Volumes up to 17,000 C.F.M.

Two Catalogs to Aid the Designer

"132 UNUSUAL USES OF SPENCER VACUUM"

Illustrates and describes how Spencer Vacuum is used in industries from A to Z.

"TURBO DATA BOOK"

Supplies application data on Spencer Blowers. Request Bulletin 107-C.

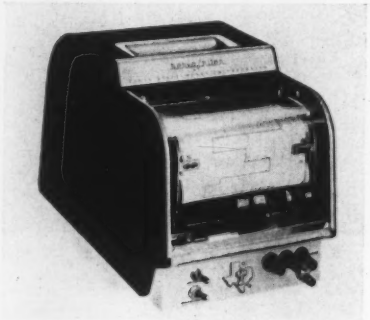
The SPENCER TURBINE COMPANY
HARTFORD 6, CONNECTICUT

available so that sensitivity, band width, and other characteristics can be set up for present requirements yet remain fully flexible for future use. One basic oscilloscope covers a wide range of low-frequency applications in electronic research and development, medical research, biology, atomic physics, television, automation, and production-line testing. Main frame indicator consists of a 5-in., single-gun, cathode-ray tube, associated beam controls, identical x and y main amplifiers, and power supply. **Electronic Tube Corp.**, 1200 E. Mermaid Lane, Philadelphia 18, Pa. E

Circle 707 on Page 19

Servo Recorder

has high sensitivity and fast response



Servo/Riter recorder is available in wide and narrow-chart, and single and dual-channel models. It features high sensitivity, fast response time, and superior interference-rejection capabilities. Unit has span step response time of less than 0.5 sec on a 4.5-in. chart. Power sensitivity is better than 10^{-17} w with off-balance input resistance of 4 megohms and standard electrical span of 2.5 mv dc. All models incorporate ten-speed chart drive and high-capacity ink-handling system. **GeoSciences and Instrumentation Div., Texas Instruments Inc.**, 3609 Buffalo Speedway, Houston 6, Tex. P

Circle 708 on Page 19

Medium-Volume Whiteprinter

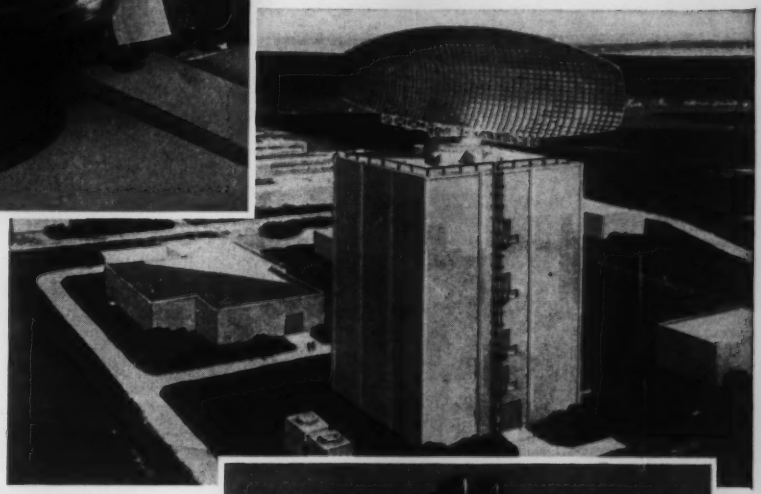
has speed to 40 fpm

Economical, medium-volume whiteprinter features 42-in. printing width, 3000-w lamp, and mechani-

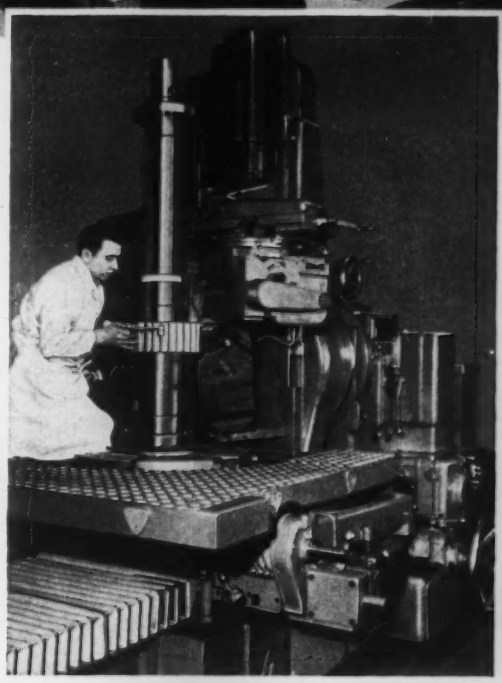
Circle 552 on Page 19

PRECISION 141" INTERNAL GEAR

by PHILADELPHIA



. . . WILL REVOLVE THIS 70 TON AIR-SEARCH RADAR ANTENNA ASSEMBLY ➡



Where precision gears are required for defense or industry—Philadelphia has the equipment and manpower to do the job efficiently and economically.

The 141" internal spur gears recently furnished for traversing the large Radar Screens on this fortress-like tower shown above were manufactured to the most critical accuracy requirements. The equipment will become part of Continental Aircraft Control and Warning System which searches out and identifies cruise-type missiles and aircraft through an intricate network of Air Force Radar Installations.

These five story towers, housing a complex electronic system designed and manufactured by the Sperry Gyroscope Company, are an integral part of the SAGE Complex.

The drive mechanisms furnished by Philadelphia Gear incorporate perhaps the most accurate large internal gears ever manufactured. The 141" gears, having 282 teeth, are accurate within 20 arc seconds (17/1,000,000 part of circle) and the hardened and ground tooth pinions also manufactured by Philadelphia are accurate within 10 arc seconds (8/1,000,000 part of circle).

Where reliability and accuracy are required in precision or industrial gearing—you can depend on Philadelphia Gear for the best.

phillie gear®

PHILADELPHIA GEAR CORPORATION

ERIE AVE. & G STREET, PHILADELPHIA 34, PENNA.

Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID MIXERS • FLEXIBLE COUPLINGS

Virginia Gear & Machine Corp. • Lynchburg, Va.

put HEINZE in your designs

MAN!

these

HEINZE D2 BLOWERS

are REAL COOL

Like wow! Heinze D2 Blowers, with durable plastic housings, are ideal for circulation of air, for cooling electronic components and equipment, and for cooling operations in vending machines, laboratories and similar applications.

Powered by the exceptionally long-lived Type D 2-pole shaded pole induction motor, single blower unit delivers 10 cfm (free air), double unit 20 cfm, at 3100 rpm. Rated for 115 V, AC, 60 cycles, blowers are also available for 50 cycle operation. CW or CWW rotation.

Standard units are available from stock for immediate delivery. Send coupon for complete technical data.

SEND COUPON FOR NEW CATALOG

HEINZE ELECTRIC COMPANY
685 Lawrence St.
Lowell, Mass.

Sub-Fractional Horsepower Motors and Blowers

Heinze Electric Company, Dep't D
685 Lawrence St., Lowell, Mass.

Please send literature and prices on the entire line of Heinze Blowers.

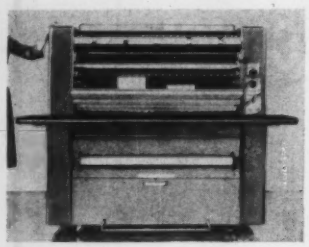
Name & Title.....

Company.....

Street & No.....

City & State.....

Circle 554 on Page 19



cal speed to 40 fpm. Built-in conveniences of Model 435 include air-jet separator which automatically separates tracings from prints after exposure, and foot treadle for releasing incorrectly fed stock. Unit is heavy-gage metal, welded and reinforced for additional strength. Air-filtering system assures cleaner lamp cylinder, cleaner prints, and high rate of production. Top front tray can be adjusted from 18 to 24 in. in depth by sliding end stops in or out. Tray is also split to permit stacking of two different print sizes simultaneously if desired. **Charles Bruning Co.**, 1800 W. Central Rd., Mt. Prospect, Ill. J

Circle 709 on Page 19

Audio-Frequency Voltmeter

is accurate to ½ of 1 per cent

AF voltmeter, Type M-121, measures audio and low radio-frequency signals to accuracy of ½ of 1 per cent. Full-scale ranges of the portable instrument are 1 mv to 100 v rms; frequency range is from 20 cps to 400 kc. Input impedance is 10 megohms. Facilities for balanced and unbalanced inputs are provided at 100,000 and 600 ohms impedance. Voltmeter incorporates two preset controls which can be adjusted to set up full-scale deflection, at a specified frequency, on any given range. Accuracy is limited only by accuracy of external source. Readings of less than full scale will be within ± 0.3 per cent,

From raw material to finished product, she's the expert and the boss at every step.

For the same reasons, only the company who controls the metallurgical quality of beryllium copper from raw ore to finished strip can assure you the most accurate dimensional tolerances obtainable commercially, oxide-free strip surface for prolonged die life and precise metallurgical properties tailored to your specific needs.

The Brush Beryllium Co. and its Pennrold Division offers you the world's most completely integrated facilities for the production of the finest precision beryllium copper strip rolled today. With it, you get complete application and fabrication field engineering service, the widest range of sizes (down to 0.0005" thick) and the largest coil size in the industry (for greater uniformity and faster delivery).

The same precise metallurgical control and complete field engineering service is also available to users of precision rolled phosphor bronze and other special purpose alloy strip.

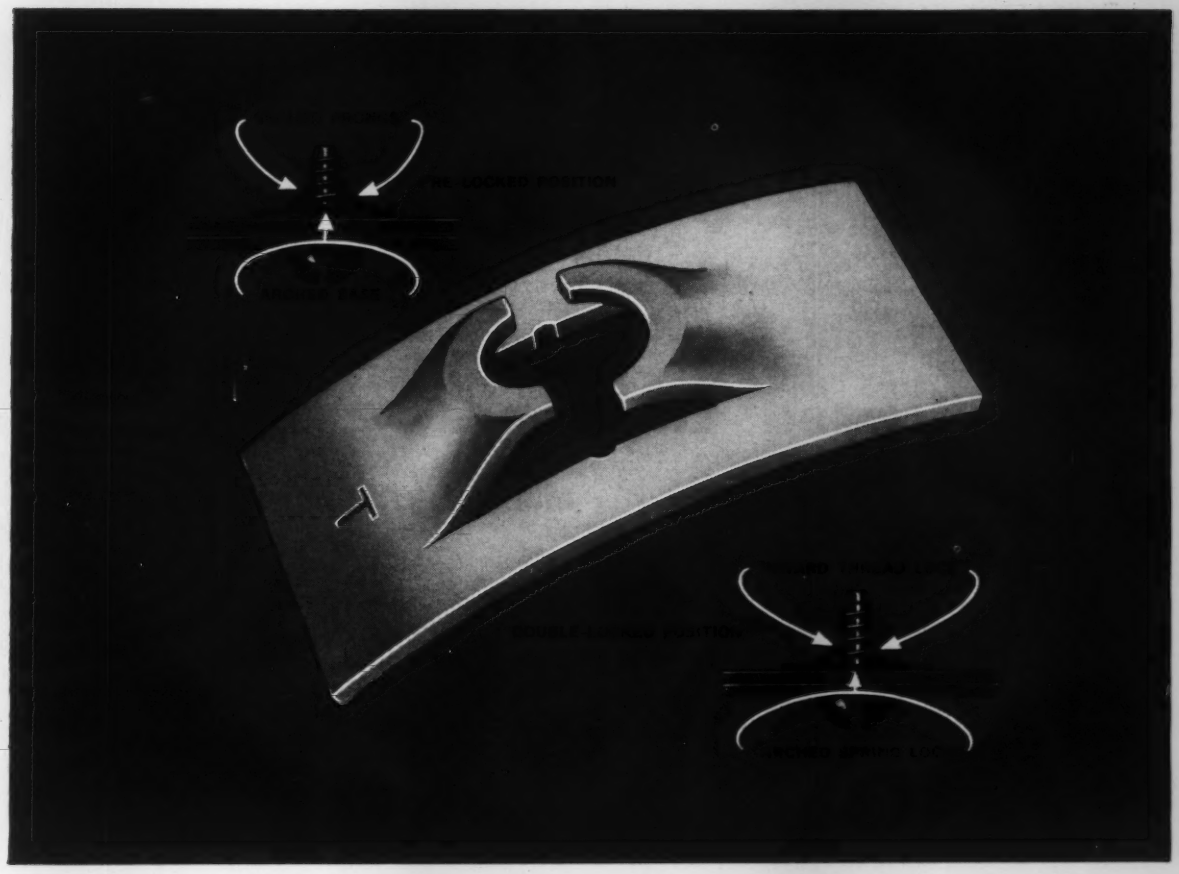
For more information, quotations, or fast delivery—call your nearest Pennrold Service Center, today!

PENNROLD DIVISION
501 Crescent Avenue/Reading, Pennsylvania

Service Centers and Warehouses

Reading, Pa.— FRanklin 5-4361
Southington, Conn.— MArket 8-5574
New York, N. Y.— WAlker 5-7500 or Enterprise 6479
West Paterson, N. J.— CLifford 6-1085
Philadelphia, Pa.— MOhawk 4-6749
Pittsburgh & Cleveland— Cleveland, ENdicott 1-5400
Chicago, Ill.— GLadstone 5-7850
Detroit, Mich.— TUxedo 4-2530
St. Louis, Mo.— SHerwood 1-6423
Greensboro, N. C.— BRoadway 3-5973
Los Angeles, Calif.— PLeasant 3-5531

Circle 555 on Page 19



Another Tinnerman Original...

Self-locking **SPEED NUT®** goes on fast, never shakes loose...and reduces costs!

With only one piece to handle, you can quickly position this Tinnerman Flat-Type SPEED NUT in screw-receiving position in one motion. No threaded nuts, no lock washers, no spanner washers to worry about.

Drive the screw and this spring-steel fastener locks tight, never to shake loose; yet easy to remove and reuse whenever you desire. SPEED NUTS won't freeze on screw threads!

Tinnerman Flat-Type SPEED NUTS are made in a full range of sizes, tensile strengths and corrosion-resistant finishes. Design variations also provide many multiple-function special types.

Lower cost per thousand plus lower cost of assembly give you maximum cost-reduction benefits... with maximum fastening assurance.

For more information, refer to your Sweet's Product Design File, section 7-Ti. Your Tinnerman representative has samples and prices. He's listed under "Fasteners" in the Yellow Pages. Or write to:

TINNERMAN PRODUCTS, INC.
Dept. 12 • P.O. Box 6688 • Cleveland 1, Ohio

TINNERMAN
Speed Nuts®

FASTEST THING IN FASTENINGS®

CANADA: Dominion Fasteners Ltd., Hamilton, Ontario. GREAT BRITAIN: Simmonds Aerocessories Ltd., Treforest, Wales. FRANCE: Simmonds S. A., 3 rue Salomon de Rothschild, Suresnes (Seine). GERMANY: Mecano-Bundy GmbH, Heidelberg.

Wanted: Engineers

with an interest in writing

Like to break into an interesting field where you'll make good use of your engineering talents — yet have a chance to develop new skills?

We're looking for several men with engineering experience and a yearning to write or edit. As an editor on MACHINE DESIGN, you would broaden your engineering background in a job that provides stimulating contact with people in many engineering areas.

You don't have to have actual writing or editing job experience, although we expect definite ability in handling the English language. An ME or EE degree plus several years of design-engineering experience would be ideal, but we'll be happy to consider equivalent qualifications. Age: 25 to 35.

If you've worked in a design-engineering specialty area, we'd like to hear about it. We're interested in any job experience or training in:

- Mechanical drives, controls, systems
- Mechanical components, assemblies
- Electrical or electronic drives, controls, systems
- Hydraulic or pneumatic systems, drives, controls
- Materials and finishes selection or specification
- Design for manufacture or production design

Our headquarters are in Cleveland. There is opportunity for travel to engineering meetings, expositions, and manufacturing companies. Salary will depend on your background and experience.

If you are interested, send a resume of your engineering background, and any evidence you may have of writing ability (we'll return this if you wish) to: Editor, MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio.

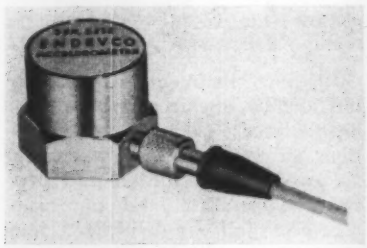
MACHINE DESIGN

and full-scale values on other ranges will be within ±0.2 per cent. Readings are displayed on individually calibrated meter with scale length of 6 in. Mirror is provided to eliminate parallax errors, and no set zero adjustments are necessary. **Wayne Kerr Corp.**, 1633 Race St., Philadelphia 3, Pa. E

Circle 710 on Page 19

Lightweight Accelerometers

for −65 to +350 F temperature range



Models 2232 and 2235 hermetically sealed accelerometers weigh less than 1.1 oz and measure 0.71 x 0.61-in. diam with ⅝-in. hex base. They are for temperatures from −65 to +350 F. Model 2232 has high first resonant frequency of 50 kc and Model 2235 of 40 kc. Both units offer frequency range response of 1 cps to 10 kc ±5 per cent with 1000-megohm load. Both units provide 1800 mmf nominal capacity. **Endevco Corp.**, 161 California Blvd., Pasadena, Calif. L

Circle 711 on Page 19

AC Voltmeter

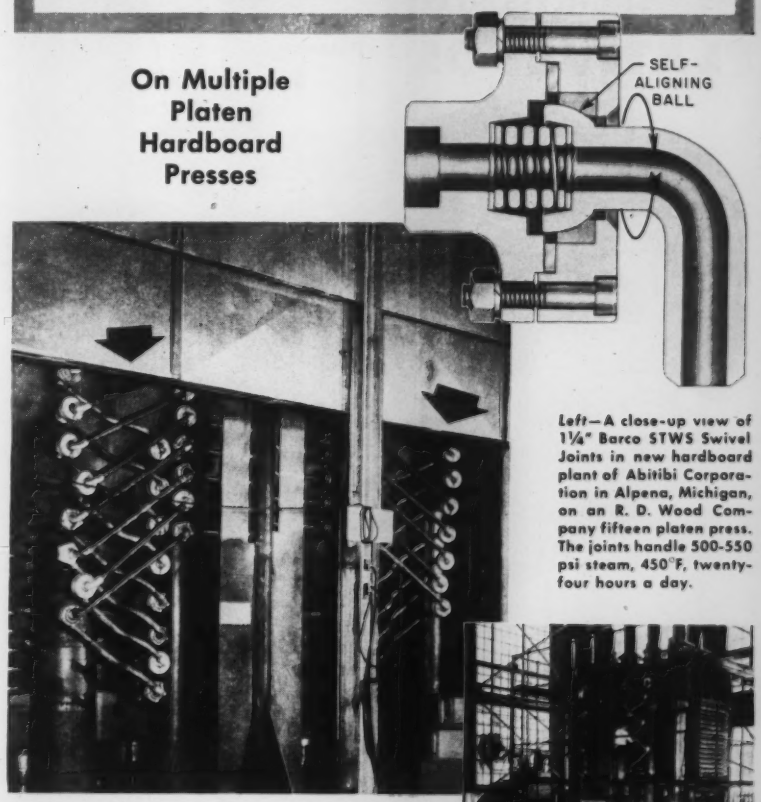
has 1 cps to 1 mc frequency range

Model 403A voltmeter is a transistorized, compact, portable instrument weighing less than 5 lb. It measures ac voltages from 1 mv to 300 v full scale with accuracy of ±3 per cent from 5 cps to 500 kc and ±5 per cent from 1 to 5 cps and 500 kc to 1 mc. Instrument has 12 voltage ranges and also reads from −72 to +52 db. Voltmeter has 400-hr battery life. Noise is less than 50 mv, and instrument is completely isolated from power-line or ground interference. **Hewlett-Packard Co.**, 275 Page Mill Rd., Palo Alto, Calif. M

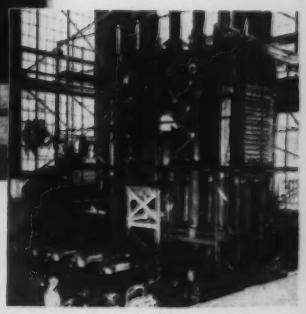
Circle 712 on Page 19

How to Handle 550 psi Steam –Use BARCO Series 850 Swivel Joints!

On Multiple Platen Hardboard Presses



Left—A close-up view of 1¼" Barco STWS Swivel Joints in new hardboard plant of Abitibi Corporation in Alpena, Michigan, on an R. D. Wood Company fifteen platen press. The joints handle 500-550 psi steam, 450°F, twenty-four hours a day.



HIGH PRESSURE STEAM SERVICE

The Barco "Series 850" Swivel Joint is a new development. It is *the key* to solving many PIPING FLEXIBILITY problems where high temperatures and pressures are encountered. Many of these joints are now being used to make flexible "Dog Leg" piping connections for steam supply and condensate drainage of movable platens on giant hardboard presses, as illustrated by the accompanying photographs.

Barco "Series 850" Swivel Joints offer important advantages: (1) Built for 850 psi steam pressure rating—steel construction, hardened ball, stainless steel spring; (2) Choice of seals to handle 500°F, 750°F, or even 1000°F temperature; (3) Ability to stay in service 24 hours a day, 7 days a week, for month after month without maintenance; (4) Compact design, with Barco's distinctive "self-aligning" feature which make for quick, easy, economical pipe fitting; (5) Choice of 90°, 180° or straight body styles with threaded or welding end connections, in a range of sizes.

Engineering recommendations and detailed information on request; ASK FOR CATALOG 265D.

PRODUCTS BACKED BY EXPERIENCE
BARCO
FOUNDED 1908

BARCO MANUFACTURING CO.
5061 Hough Street, Barrington, Illinois
The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Rotary Joints
In Canada: The Holden Co., Ltd., Montreal

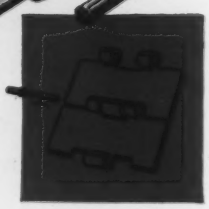
ASK FOR CATALOG 265D

Circle 558 on Page 19

Browning
STAINLESS STEEL
FLAT-VEYOR

Moves Smoother and Quieter, Lasts Longer

Browning FLAT-VEYOR is an improved materials handling system unusually efficient for the bottling, canning, food and other industries which require speed of movement with minimum vibration. FLAT-VEYOR chain and matching sprockets coordinate perfectly to *float* your product along without drag, chatter or vibration. Corrosion-free stainless steel chain is precision built to perform freely under all operating conditions. Its simplified one-piece design eliminates troublesome plates and other attachments, reduces wear; it's stronger, easier to clean. Chain of case hardened steel also is available. Both types in 3¼", 4", 4½", 6" and 7½" widths. Matching stock sprockets have ⅝" standard bore, reboreable to 1½".



Exclusive new Sure-Lock Pin in FLAT-VEYOR chain has embossed shoulder that increases holding power, ensures perfect line-up. Because pin is free in plate curls, entire surface acts as bearing area. Result is greater flexibility, less friction, less wear.

Your Browning distributor will be glad to tell you more about FLAT-VEYOR and how it can help solve problems in materials handling. Bulletin CD103, containing brief specifications, will be sent on request.

Browning Manufacturing Company
Maysville, Kentucky

THE ENGINEER'S Library

Recent Books

Thermodynamics. *By Gordon J. Van Wylen, professor of mechanical engineering and chairman, Dept. of Mechanical Engineering, University of Michigan; 567 pages, 5¾ by 9 in., clothbound; published by John Wiley & Sons Inc., 440 Fourth Ave., New York 16, N. Y.; available from* MACHINE DESIGN, *$7.95 per copy postpaid.*

Rigorous treatment of fundamentals and an engineering perspective are featured. Concepts and definitions are presented only when they are needed. Specific volume, pressure, temperature, and pure substance are initially defined. Use of thermodynamic tables is explained as terms are introduced.

After the first law is presented, a closed system and internal energy are defined. Relationships of enthalpy and the open system, and the second law and entropy are explained. Concepts of availability and irreversibility are developed as analytical tools. Reciprocating machinery and cycles are treated perspectively, and basic fluid-flow topics are discussed.

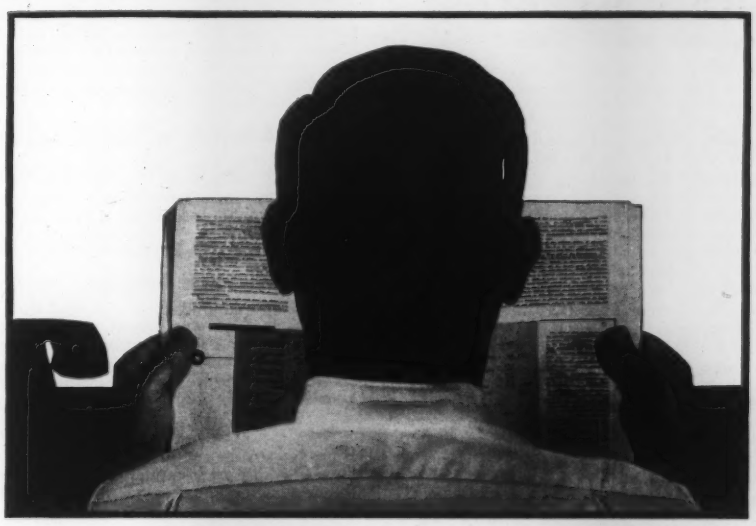
Manufacturers' Publications

Metallizing Handbook. *By H. S. Ingham and A. P. Shepard; 320 pages, 6 by 8½ in., clothbound; published by and available from Metallizing Engineering Co. Inc., Westbury, Long Island, N. Y.; $5.00 per copy.*

Both technical and practical aspects of industrial metallizing are presented in this seventh edition. Advances in wire metallizing extend from new sealed coatings for corrosion resistance to metallizing of engine cylinders using electronically automated equipment. Surface preparation, metal selection, and sprayed-metal properties are described.

A new section covers "flame spraying" of metals and ceramics. Spray-welding, also a new process, consists of first spraying and then fus-

$1000 REWARD



For the capture of this man's ATTENTION

This is the opportunity you've been looking for—a chance to create a really effective businesspaper advertisement.

YOU CAN EARN $1000

To satisfy this long-time, deep-felt urge—and earn $1000 in the bargain—send us copy and a rough layout for *one* advertisement (any size, color or not, as you see fit). This ad should be capable of attracting the interested attention of industrial advertisers with a stake in the automation market. It should point up the values AUTOMATION magazine holds as a medium for reaching buyers of automatic production equipment.

MORE THAN ONE WINNER

This is not a one-winner contest. AUTOMATION will pay $1000 to the creator of each advertisement it decides subsequently to use as part of its advertising campaign. AUTOMATION editors will be the judges. Contestant's identity will remain anonymous during the judging.

FOR HELPFUL BACKGROUND INFORMATION

Pertinent information about AUTOMATION's market, readers and objectives for use in preparing your entry appears on the back of this page. If you desire additional material, please write and we will send you a booklet supplying complete details.

DEADLINE IS NOVEMBER 30, 1959

The competition is open to all. Anyone with a creative flair is urged to try his skill. Yours may be just the idea we're looking for. Send completed entries to $1000 Reward, c/o AUTOMATION, Penton Building, Cleveland 13, Ohio.

Background Information to Help You Win

$1000 REWARD

(For complete contest details, please see reverse side)

The Marketing Man's Stake in Automation

Automation is the marketing man's challenge today—and in the future. His ideas *must* match this manufacturing concept. The creative marketer realizes that as an absolute first condition, automation requires the establishment of a predictable, stable, and expanding market. Economic and sociological pressures force automation on us; automation forces new marketing concepts on us.

The building of a constant market will require a more complete circuit of communication. Now, the manufacturer-customer flow of information largely goes from the maker to the buyer. But with automation, we will have to know more about what the customer wants. Needed are improved ways to get better communication from maker to user and then back again.

The Management Man's Stake

Automation, or continuous automatic production, naturally will grow out of more complete mechanization. We have progressed from the manual area through the mechanization area and are now well into automation. Any discussion about whether automation is desirable is a futile intellectual exercise. We might as well argue whether the tides and the seasons are desirable.

The dawn of mechanization at the turn of the century brought a new era of lower costs and a higher standard of living than would have been possible in a manually operated economy. Now, we are approaching the upper limits of cost and labor reduction possibilities in a mechanically operated economy. We need a new breakthrough—and it will come through automation.

In the words of D. S. Harder, former Executive Vice President, Basic Manufacturing Divisions, Ford Motor Co.

"Time has proved that the machine age is a boon—not a bugaboo . . . Manufacturers, large and small, have to make a choice. They can heed the warnings of uninformed doom prophets and retard our industrial progress—a road leading to oblivion. Or we can all have faith in ourselves and our ability to harness the potential of this new phase of industrialization for the benefit of all."

The Manufacturing Engineering Function

When industry first backed into automation without precision engineering, it had plenty of trouble. As a result, the manufacturing engineering function developed and has become industry's fastest growing and most important buying influence for automated production equipment.

Industry is changing from a departmentalized approach to a three-phase approach.

PHASE ONE—the processing or work-performing phase, which includes all the steps that alter or combine materials.

Phase Two—the handling phase, which encompasses the movement of materials in process within or between machines.

Phase Three—the control phase, covering the automatic cycling of functions 1 and 2—either independently or integrated.

How AUTOMATION Serves This Function

Edited for men with *manufacturing engineering* interests and responsibilities . . . AUTOMATION serves all industries. It reports and interprets all significant advancements and trends relating to automation, including planning, development, design, installation and maintenance. It provides for the exchange of ideas from one industry to another. This cross fertilization is the time-and-money saving link between those who have solved a production process problem and those who are still looking for a solution.

Why Users Read AUTOMATION

AUTOMATION is directed particularly to manufacturing engineering and operating management men in industry who are responsible for, or directly interested in, automation. Editorial and advertising pages provide the basis for their decisions concerning the adoption or improvement of automated equipment and manufacturing systems for their own use.

Why Designers and Builders Read It

In addition, AUTOMATION appeals to engineers and management men in companies that serve the special automation needs of industry . . . the manufacturing engineering function *to* industry. It gives designers and builders specific job help relating to all types of automated original production equipment . . . from single automatic machines to fully integrated lines and plants.

Reaches a $5 Billion Market

A continuing industry-wide study pinpoints the tremendous potential for Production Equipment, Handling Equipment, Power Drives and Automatic Control Equipment in this vast market controlled by the manufacturing engineering function. This "Survey Report and Automation Forecast" provides you with a new measure of marketing trends. Ask your AUTOMATION Representative to show you how to incorporate its data into *your* marketing plans.

Attracts a 90,000 Buyer Audience

AUTOMATION's vital readership is concentrated among 90,000 key buying influences . . . the manufacturing engineering and management men who specify, recommend, approve and buy your products. It reaches the important influences of the buying team . . . the men your salesmen don't always get a chance to contact and, yet, would *prefer* to contact.

High Response to Editorial

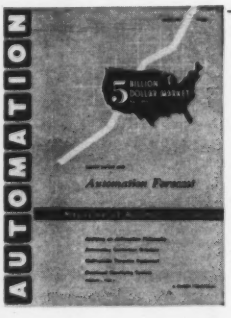
Written by manufacturing engineers for manufacturing engineers . . . AUTOMATION is geared to the exact needs and wants of its readers. Its editorial pages clearly communicate—create respect and response! This high level of reader interest is documented by reprint requests (averaging over 130,000 annually) and continually high Starch readership scores.

High Response to Advertising

Every advertisement in AUTOMATION is directed to the manufacturing engineering function, production-management men, or the designers of production equipment. No waste circulation . . . for every reader has the *need* to know about these products and the *power* to buy them.

Market Planning Help

You get more effective results from your advertising and help in reaching key automation-minded men in industry, too, with a complete marketing plan which includes: The Penton Census . . . the Continuing Industry-Wide Study of Automation . . . Reader Action Reports . . . Market Data Sheets . . . Starch Scores . . . plus many other Merchandising Aids. Your AUTOMATION Representative is prepared to help you make the most of industry's fastest growing and most influential function—*manufacturing engineering.*



Get ACTION from the men who buy and specify . . .

- *Production Equipment*
- *Handling Equipment*
- *Power Drives and Automatic Control Equipment*

AUTOMATION

A Penton Publication
Penton Bldg., Cleveland 13, Ohio

ing a coating to the desired object. Equipment used, different powders and alloys, application to inside diameters, and methods of finishing various sprayed coatings are discussed and illustrated.

Forging — Product Information. 322 *pages, 5¼ by 8¼ in., clothbound; published by and available from Technical Publications Dept., Kaiser Aluminum & Chemical Sales Inc., 1924 Broadway, Oakland 12, Calif.; free on company letterhead, $7.50 per copy for personal libraries.*

This manual describes the development, design, production, and application of aluminum forgings. Production of a typical forging is described in detail through original design, sinking of the die, progressive forging steps, finishing, and final inspection. Engineering data, presented throughout in tabular and graphical form, include alloy selection, mechanical and physical properties under various conditions, die and forging design recommendations, types and availability of forgings, and metallurgical control. Forging magnesium and titanium is also discussed.

Government Publications

OTS Technical Reports. Copies of reports listed below are available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.

PB 131423R. Environmental Requirements Guide for Electronic Component Parts. 11 pages, 7⅞ by 10¼ in., paperbound, stapled; $0.50 per copy.

Superseding the October 1957 handbook, this guide was prepared by Advisory Group on Electronic Parts and Advisory Group on Electron Tubes. Environmental design requirements and appropriate test procedures are established for present and future electronics planning in research and development. Conditions covered are temperature, pressure, moisture, vibration, shock, explosion, radiation, sand, dust, salt, fire, and fungus.

PB 151064. Coatings for Protecting Molybdenum from Oxidation at Elevated Temperature. By E. S. Bartlett, H. R. Ogden, and R. I. Jaffee, all of Battelle Memorial Institute; 39 pages, 8½ by 11 in., paperbound; $1.25 per copy.

Available information on the more promising coating systems developed to date are reviewed. Data on protective qualities of the better coatings are reported. Coating methods include electrodeposition, flame-spraying, vapor and pack-deposition, cladding, enameling, and liquid-phase diffusion. Examples of coatings applied to functional molybdenum parts are cited.

PB 151649. A Modern Dynamic Approach to Product Development. By Sidney Sobelman of Picatinny Arsenal; 200 pages, 7⅞ by 10¼ in., paperbound, side-stapled; $3.50 per copy.

Elements of a product, time factor, pay-off as a criterion, and scheduling of many projects among many teams are analyzed as basic considerations designed to stimulate product development organizations to increase their profits and reduce costs and lead-times. Mathematical models are developed for quantitative analysis of product development, applied research, and possibly basic research.

A topper in any language

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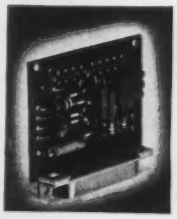
When you want extremely high reliability in printed circuits, with the additional advantages of flame retardance, chemical resistance, good solderability and high bond strength—specify Taylor XY-1 copper-clad laminate. It is self-extinguishing in 1 second, has excellent resistance to alkalis, acids and solvents, has a solder time resistance at 500°F. of 30 seconds in 1-oz. copper and 50 seconds in 2-oz., and a bond strength of 10 lb. in 1-oz. copper and 13 lb. in 2-oz. Sheets available with copper on one or both sides.



Unclad Taylor XY-1 has many advantages, too. It can be substituted for glass-base epoxy laminates to reduce cost and weight. It has excellent electrical, mechanical and machining properties. Contact us for complete technical data and expert guidance in applying this new material. TAYLOR FIBRE CO., Norristown 47, Pa.

Taylor

LAMINATED PLASTICS VULCANIZED FIBRE

Circle 560 on Page 19

Versatile Humphrey
"Quick-Dump"
Valves Provide
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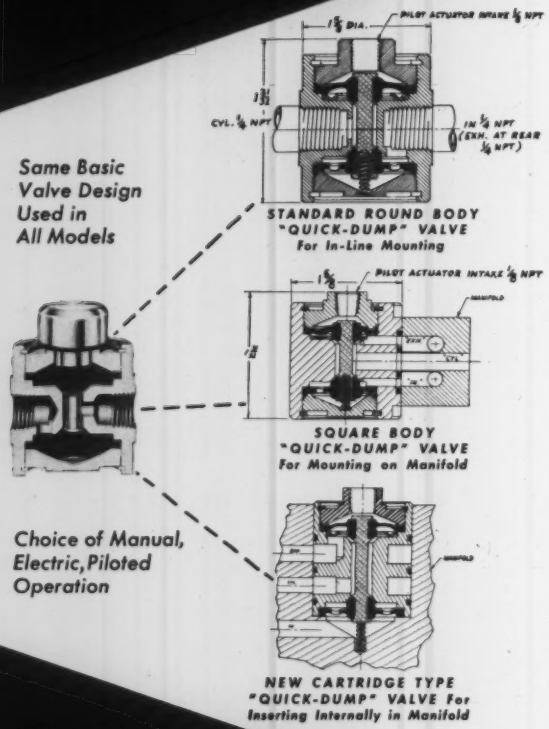
Pneumatic Controls


Same Basic Valve Design Used in All Models
STANDARD ROUND BODY "QUICK-DUMP" VALVE For In-Line Mounting
SQUARE BODY "QUICK-DUMP" VALVE For Mounting on Manifold
Choice of Manual, Electric, Piloted Operation
NEW CARTRIDGE TYPE "QUICK-DUMP" VALVE For Inserting Internally in Manifold

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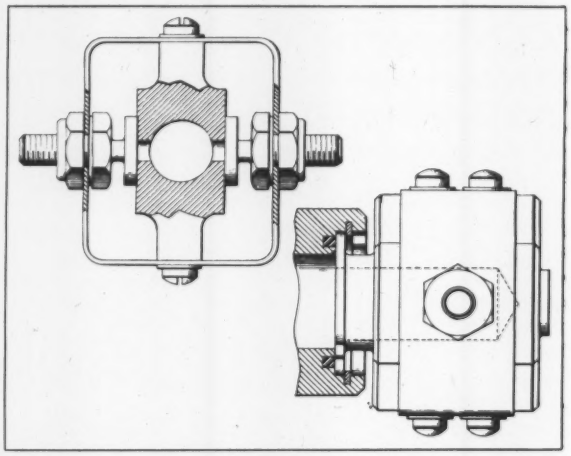
NOTEWORTHY Patents

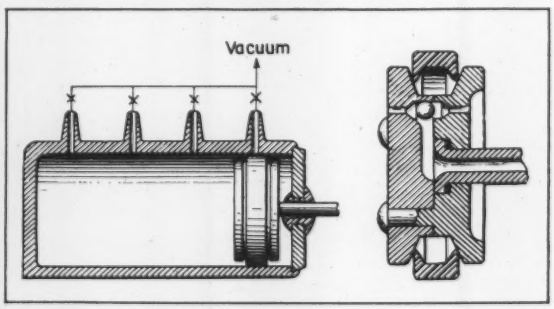
Pneumatic Overspeed Governor

Light weight, small size, and frictionless operation are features of an adjustable pneumatic governor. Functional components are two poppet valves fastened in a flexible casing and held, by the casing, against opposite ends of coaxial ports. The governor is mounted



against the end of a hollow, rotating shaft which carries a working fluid. At a predetermined shaft speed, centrifugal force opens the poppets against the force of the spring casing. Resultant pressure differential operates inlet fluid controls. The critical speed can be changed by changing the positions of the poppet valve fastenings. *Patent* 2,896,653 *assigned to The Garrett Corp., Los Angeles, by Elmer D. Marlin.*

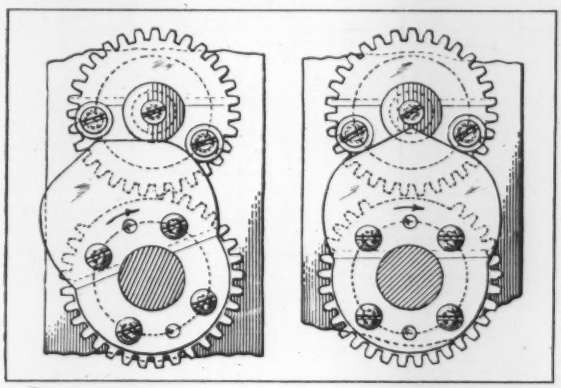
Vacuum-Actuated Positioning Device



A piston can be positioned in a cylinder at any of a number of locations all of which are connected, through valves, to a source of vacuum. Inside the piston is a ball valve which has coaxial openings to both faces of the piston. The valve chamber is open to the atmos-

phere through a channel in the piston and the hollow center of the piston rod. When any of the positioning valves is opened, the ball closes the piston port nearer the opened valve and atmospheric pressure moves the piston until it seals the channel to the vacuum source. *Patent 2,895,455 assigned to Shakespeare Products Co., Kalamazoo, Mich., by Garth Anthony Clowes.*

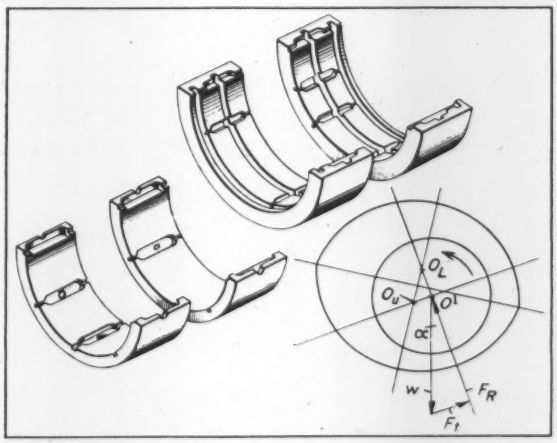
Intermittent Motion Drive



A cam attached to a gear in a pair provides departure from a fixed speed ratio over a certain arc. Fixed to the driving gear, the cam extends beyond the root circle of that gear throughout the arc and engages two roller followers on the driven gear. Teeth of the driving gear are removed throughout the arc. *Patent 2,898,775 assigned to E.R.D. Laboratories Inc., by Henry Reid.*

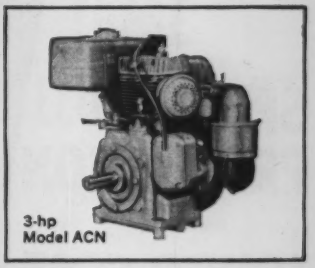
High-Performance Bearings

Plain and elliptical bearings have oil grooves specifically located to prevent or substantially reduce half-frequency whirl and resonant whip in shafts. This

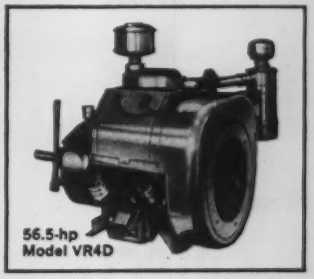


design increases the forces which tend to damp whirling action, and also extends the threshold of whirl frequency above the operating frequency of the shaft. In both bearing types, axial oil grooves are located where

Beat your competition at their own game—



specify **WISCONSIN** heavy-duty air-cooled **ENGINES** for your power equipment!



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Your toughest competitor can often be your best friend! Especially if his almost-identical *but Wisconsin-powered* equipment outworks, outlasts, and outsells your machines.

His success shows that power makes the difference. It proves that you too can rely on Wisconsin air-cooled engines to improve the performance and service life of your equipment — and to increase customer satisfaction.

Here's why: Wisconsin engines are precision-fitted to give the most hp-hours of service with the least care. They furnish fast-starting, smooth-firing power in sub-zero cold or in 140° F. heat — and respond with load-lugging power to ease your equipment through sudden shock loads.

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Take a tip from your competition — specify Wisconsin air-cooled engines for your power equipment. Sizes range from 3 to 56 hp — tailored to your needs — in 4-cycle single, two-, and V-type four-cylinder models. Get Bulletin S-237.

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Circle 562 on Page 19

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GRIP-NUT family of GRIPCO FASTENERS

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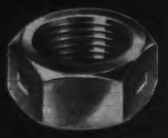
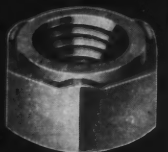
One piece all metal.



GRIPCO CENTERLOCK NUT
Locking feature in the center for fast feeding. Can be applied from either end.

GRIPCO CLINCH NUT
With or without Gripco Lock. For application to metal too thin to thread or for inaccessible assemblies. Hex collar prevents turning when torqueing bolt.



GRIPCO PILOT-PROJECTION WELD NUT
With or without Gripco Lock. Centering collar positions nut and protects threads from weld spatter.

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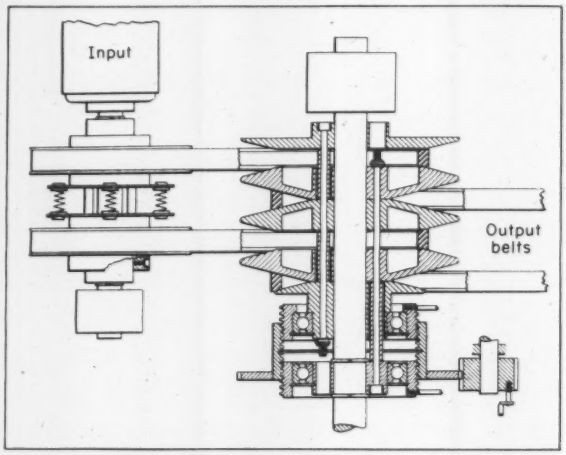
lubricant film pressures are highest. In addition, and for the same purpose, the axes of elliptical bearings are inclined to the horizontal. *Patent* 2,901,297 *assigned to General Electric Co. by Beno Sternlicht.*

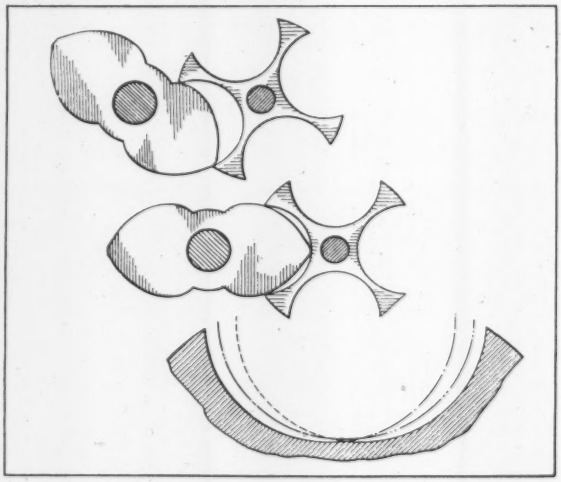
Adjustable-Speed V-Belt Drive

Vernier speed adjustment in a V-belt drive is provided by an intermediate control assembly between similar input and output assemblies. All assemblies



have variable-pitch sheaves. Positive axial positioning of alternate sheave halves in the control assembly determines belt tension. Changes in tension are accommodated automatically by changes in pitch diameter, and speed, of the spring-loaded input and output sheaves. *Patent* 2,900,832 *assigned to Allis-Chalmers Mfg. Co., Milwaukee, by Joseph H. Snartemo.*

Fluid Rotor Assembly

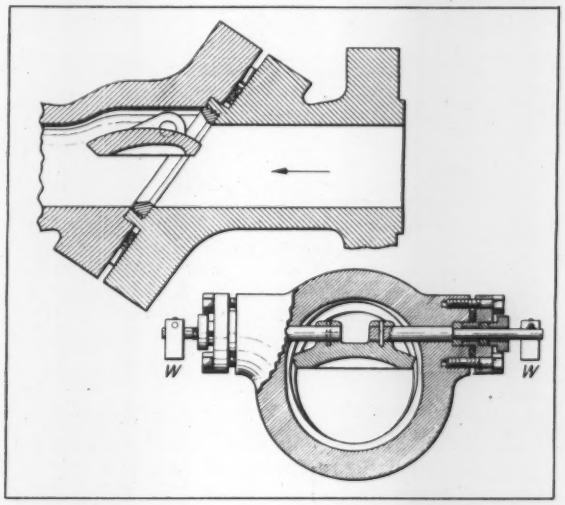


A pressure-generating pair of helical rotors provide minimum leakage and maximum efficiency due to a crescent-shaped envelope of clearances between generated contours of the main and gate rotors. The

smallest clearance occurs at the bottom of gate troughs. Torsional distortion in the assembly elements, caused by pressure imposed on fluid in the clearance envelopes, does not affect minimum clearance. *Patent* 2,901,164 *assigned to the Ingersoll-Rand Co., New York, by Joseph E. Whitfield.*

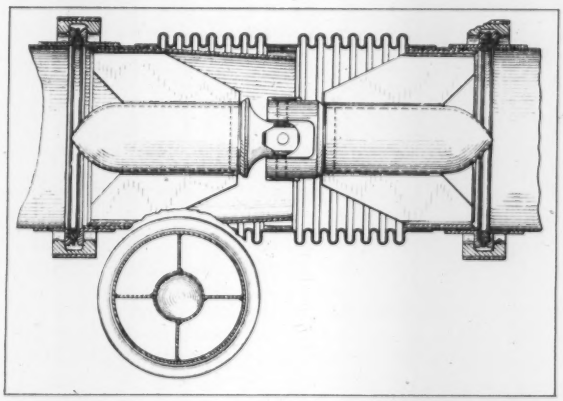
Noiseless Check Valve

Dynamic characteristics of an automatic check valve can be adjusted to prevent objectionable noise caused



by frequent operation of the valve disc. The moment of inertia of the disc, with respect to its axis of rotation, is changed without changing the mass of the disc. Eccentric weights *W* are added to projections of the disc shaft outside the casing. The weights can be adjusted independently along and around the shaft. *Patent* 2,900,998 *assigned to Phillips Petroleum Co. by Russell W. Lortz.*

Flexible Nonexpandable Joint



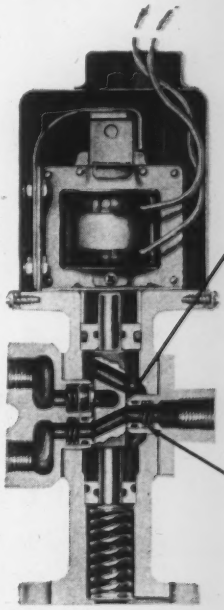
Design of a joint in a fluid line permits limited flexure but no axial elongation. Corrugated tubing, which is the outer surface of the joint, prevents loss of fluid during flexure. Inside the corrugated member, tubes

DO YOU SHARE THESE COMMON MISBELIEFS ABOUT SOLENOID AIR VALVES?

"THE SOLENOID IS TO BLAME FOR COIL BURNOUT"
Very seldom, in most cases and particularly with spool valves, sticking valve members create overloads, overheating and coil burnout.

"AIR IS FREE"
Perhaps a little ridiculous, but the way many plants waste it, you would think it was free. Actually, compressed air not properly controlled can be the most costly power medium you use. We have a study on the dollar cost of air leaks that will blow your hat off.

"AIR VALVES ARE ALL ABOUT THE SAME"
When they are new they all work fine. While all other valves start going down-hill with every operation, the sealing qualities of Barksdale Valves are improved through operation.



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WEAR COMPENSATING FEATURE CONSERVES COSTLY AIR

There is a Barksdale representative in your vicinity who has the facts supporting the above statements.

Send for the bulletin:
"Benefits offered by Barksdale AIR-SEAL Valves."

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Barksdale valves
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Circle 564 on Page 19

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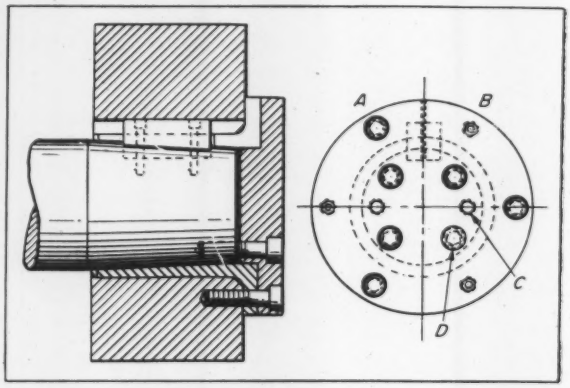
7960-A LORAIN AVE., CLEVELAND 2, OHIO

tapered at one end are fixed axially and spaced centrally by vanes which are welded to opposite ends of the joint. The tubes are joined by a simple universal joint. *Patent* 2,901,272 *assigned to Flexonics Corp., Maywood, Ill., by Raymond C. Andersen.*

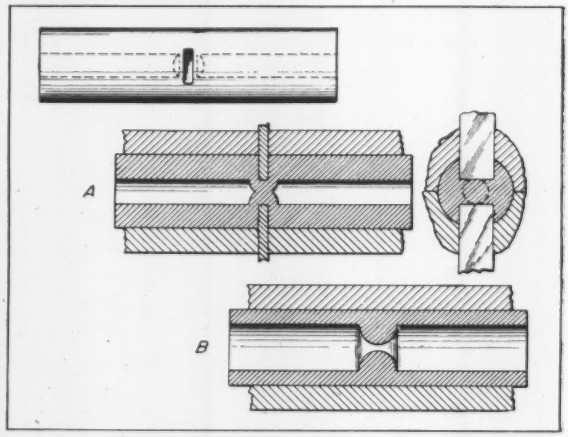
Roll Mounting and Positioning Assembly

While performing its regular function, a roll which is keyed to the end of a shaft must maintain accurate axial position. At the same time, the roll is subjected to thermal expansion which operates against accurate positioning. A wedge-like split sleeve takes up slack due



to the expansion. Restored relative positions are fixed by sets of screws *AB* and *CD*. Screws *C* and *D* space an end cap relative to the shaft. Screws *A* and *B* space the roll relative to the cap. *Patent* 2,899,222 *assigned to the Ajax Mfg. Co., Euclid, Ohio, by John L. F. Ross.*

Internal Tube Barrier



Barriers against liquid flow, pressure, and corrosion are formed in small-size tubing, less than 1 in. OD, by displacement of tube material without distortion of tubing OD. In thick-wall tubing, *A*, barriers are formed by a lance guided by an exterior die. In thin-wall tubing, *B*, internal beads are formed before the closing operation. *Patent* 2,901,003 *assigned to Burndy Corp. by Saul Rosner and Fred Heller.*

push-pull CONTROLS

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2. ***Heavy Duty***—Compression Ult. Load 1650 lbs.; Ult. tension 960 lbs.
3. ***Extra Heavy Duty***—Compression Ult. Load 3050 lbs.; Ult. tension 3900 lbs.

Positive remote controls for actuating mechanical, hydraulic or other devices. Eliminate bell cranks, pulleys and dual cables. U. S. Patent No. 2441719. All world rights reserved. Send for ENGINEERING MANUAL No. 1551 giving complete specifications covering materials, finishes, capacities. Please address Dept. MD-PP59.

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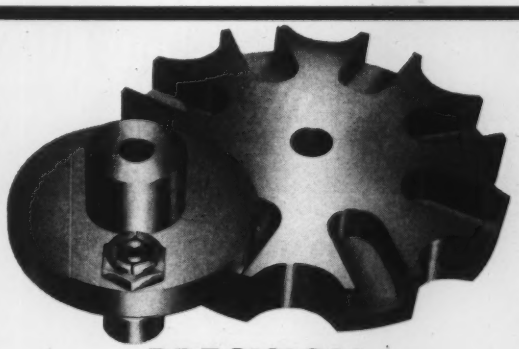
Circle 566 on Page 19



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New! Standardized miniature line now available.

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Circle 567 on Page 19

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Covered by U.S. Patents 2564044, 2568179, 2628899, 2764482, 2568180, 2584772, 2733991 and 2383473. Do not accept substitutes.

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to specs. 1/16"—4 1/4" cross flats

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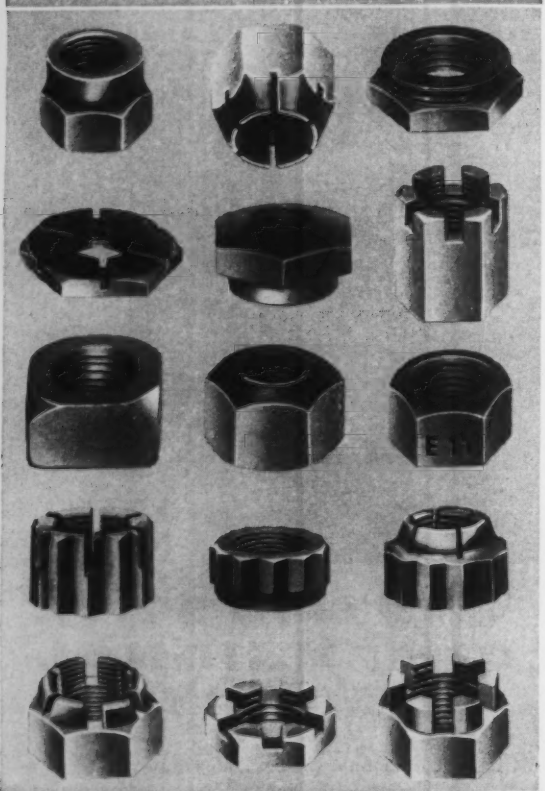

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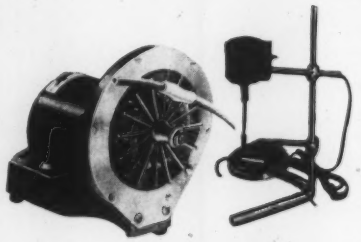
LOW COST PUMP
for Laboratory Use



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- No shaft seals
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- Non contaminating

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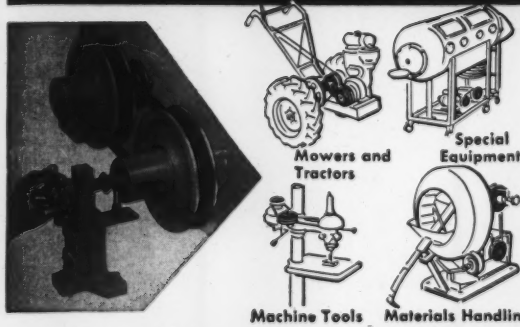

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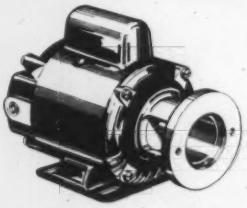
Circle 571 on Page 19



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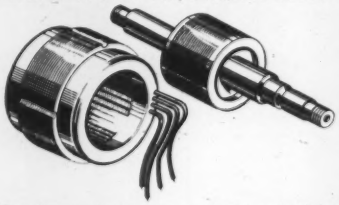

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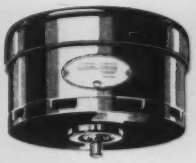

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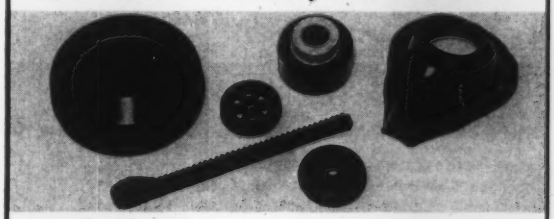

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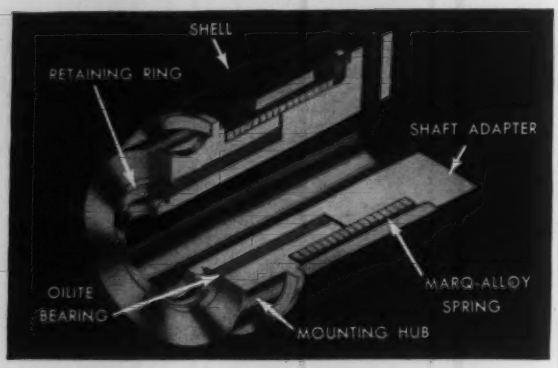

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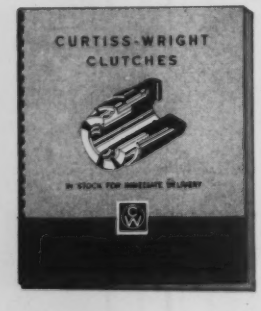

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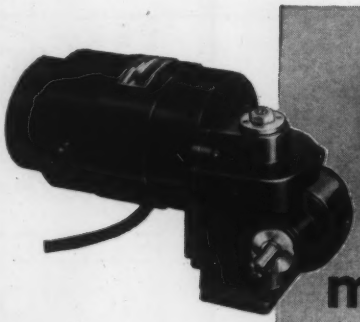

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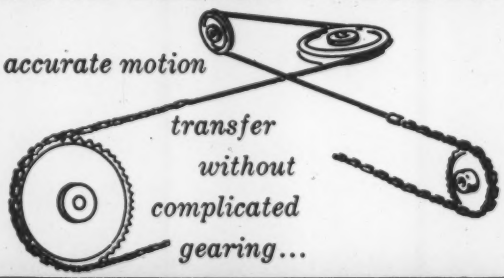

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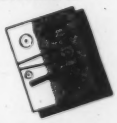

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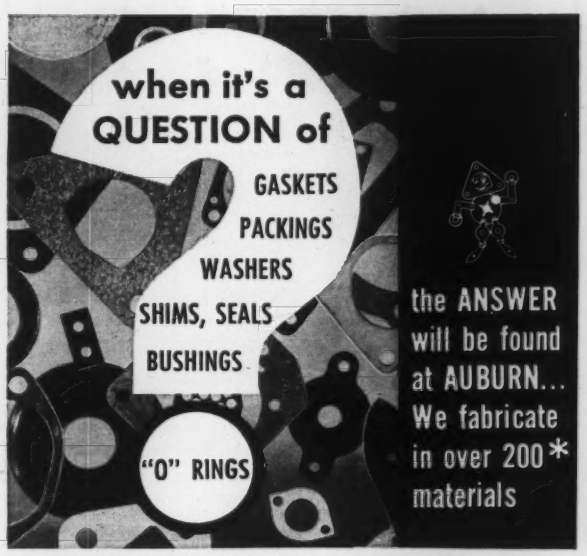

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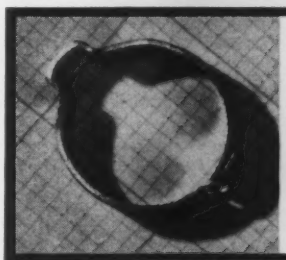

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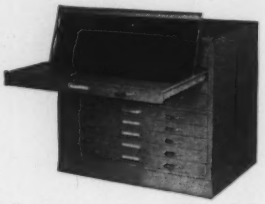

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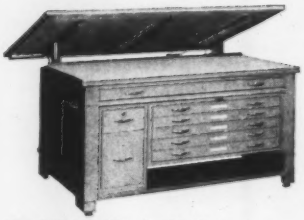

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SPRING REEL HEADQUARTERS FOR ALL INDUSTRY

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Thread Size 6-32 to ⅜-16

WF NUT
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OHIO flanged weld nuts provide extra-long thread engagement and are ideal for assemblies requiring strong primary fasteners. They can also serve as spacers or bearing surfaces where required.

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THE OHIO NUT AND BOLT CO.
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J11
Multi-Purpose

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Switch Types	N.C., N.O., or double throw, no neutral position
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Mounting	¼" NPT female, brass fitting is standard
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UNITED ELECTRIC *manufactures a complete line of temperature, pressure, and vacuum controls. For applications requiring custom-built units or modified standard units, call upon a UE application engineer for recommendations. Write for complete specification and pricing data on the Type J11. Similar data available on all other UE controls.*

UE United Electric Controls
COMPANY
85 SCHOOL STREET WATERTOWN MASS.

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EQUAL JOB Opportunity For All Qualified Applicants

Circle 588 on Page 19

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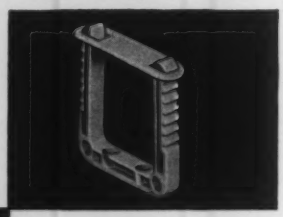

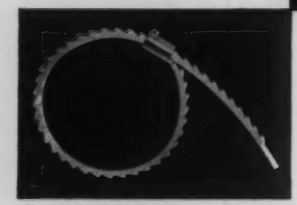

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BPA NBP

backtalk——

——Not Fit To Print

An article in our last issue offered improvements on current drafting standards, aimed to impart greatest clarity to engineering drawings which are used outside the company originating them. To temper the good ideas in that article, we now send along the suggestion that real engineersmanship can be displayed by making a simple drawing appear so difficult that no one else can read, let alone work from, it. This strategy has been immortalized by the classic draftsman's ballad:

They gave me a job in the office today,
With a hole and a couple of grooves:
It's only a cleat to go under a door
To restrain it whenever it moves.
To sketch it would take but a couple of lines,
Plus a working dimension or two,
But these wouldn't show nearly how much I know,
So I'm sure that they never would do.
I'll cut it all up into sections,
With a symbol beside every part.
I want to be sure that I make it obscure
As to where the machining will start.
It's time to put on the dimensions and then,
That's the spot where I really unload:
I'll mark all the lines with mysterious signs
That an Einstein could never decode.
My drawing is finished and printed at last,
And I'm proud of its hazy design.
I know they'll have ulcers and chaos and such,
When at last it comes out on the line.
A feeling of pride starts a stirring inside
As my tracing is filed on the shelf:
My quest has been solved with a print so involved
That I can't even read it myself.

——Knocking h Out of Nikita

It has been said that the sweetest sound in the language is that of a man's own name, correctly pronounced. Then the sweetest sight must be one's name in print, correctly spelled. If that is so, Mr. Khrushchev must have been quite unhappy when he picked up the September 17 issue of MACHINE DESIGN and noticed his name misspelled on the editorial page. The error wasn't caught until some 10,000 copies had already been printed. For one of our good friends we would have stopped the press to change the other 40,000 copies.

——Space-Age Army-Navy Game

Mention of the three words *Army, Navy,* and *recover* quite naturally conjures up a picture of representatives of the two services contesting in a football match. 'Tain't necessarily so, however, for the Navy co-operates splendidly with the Army in the recovery of nose cones such as the one containing monkeys Able and Baker. After this affair—which, of course, was carried out with the utmost seriousness—the following message was sent to the Navy recovery team from Brig. Gen. J. A. Barclay, commanding general at the Army Ballistic Missile Agency, Redstone Arsenal:

To the world's champion outfielders, our appreciation and thanks to all participants for your usual superb job in the recovery operation. You have again teamed with us in another world first—the recovery of animal specimens after a journey to outer space and re-entry into the atmosphere. Congratulations.

The Navy's team leader, Adm. D. V. Gallery, replied:

All outfielders appreciate your message but say playing outfield against you guys is easy. Apparently in this league you don't follow old baseball rule of hit 'em where they ain't.

——Getting to the Bottom of It

Whilst interviewing the 1960 cars, our newshound team of Bill Miller and Clare Wise made the grand tour of the Ford Motor Co. The attitude of one "old" car they saw struck our astute editors as most curious: A 1959 Mercury was hanging by a hook from its anterior end, resting its front bumper on a foam-rubber cushion. In reply to the subtle query, "What's *that*?" our boys learned that the car was hanging there for the purpose of having a photograph taken of its underside. The photograph was requested by a prominent maker of car-model kits, whose customers have put up a squawk over the Mercury bottoms furnished in the kits. The young fry, who apparently spend a good bit of their time on their backs underneath automobiles, complained that the bottoms of the model cars did not look like the real thing.

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TIPS AND TECHNIQUES

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Circle 591 on Page 19→

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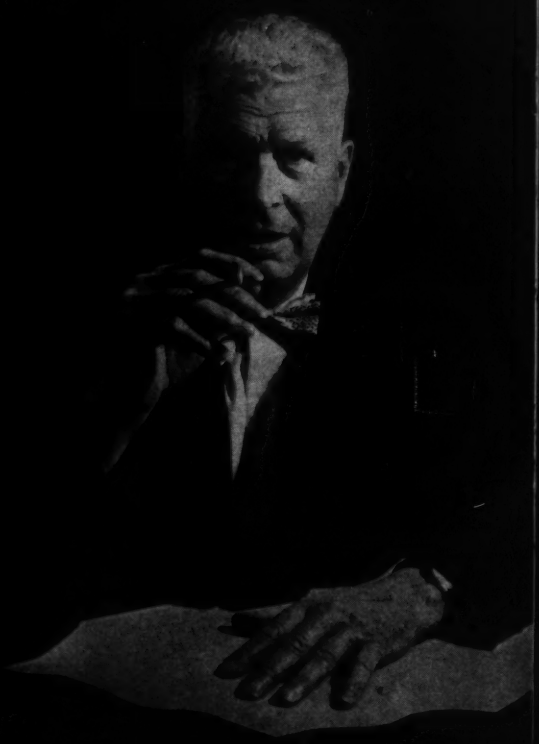

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Total downtime? I've replaced this valve myself in less than 30 seconds. You buy **trouble-free performance** and **minimum downtime**. I sell **trouble-free performance** . . . and **a new minimum downtime record**. Write today.

N. C. HUNT, PRESIDENT

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- ☐ Simplicity
- ☐ Speed and Capacity
- ☐ Price and Quality

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the SIMPLICITY story.

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buy your horsepower at the output shaft

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Master Gearmotors are packaged components, engineered to meet your requirements from line voltage to keyway dimensions. Motor and reducer are built as a single, rigidly aligned unit. These compact drives offer maximum efficiency and durability at minimum cost.

You can reduce engineering and assembly expenses by giving Master the responsibility for the entire power package. With Master Gearmotors you buy your horsepower where you need it, at the output shaft.

Vertical and horizontal, right angle and parallel shaft, worm, helical and herringbone gearing—⅛ thru 125 hp.

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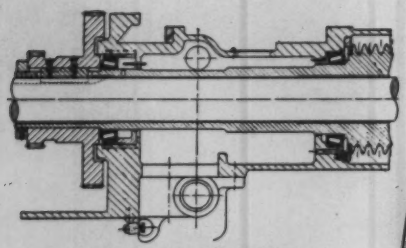
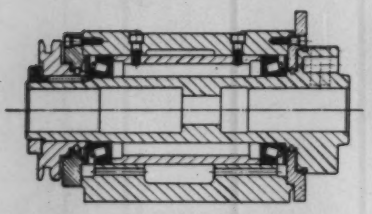
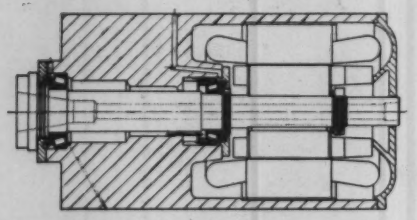


BORING MILL SPINDLE



GRINDER SPINDLE WORK HEAD



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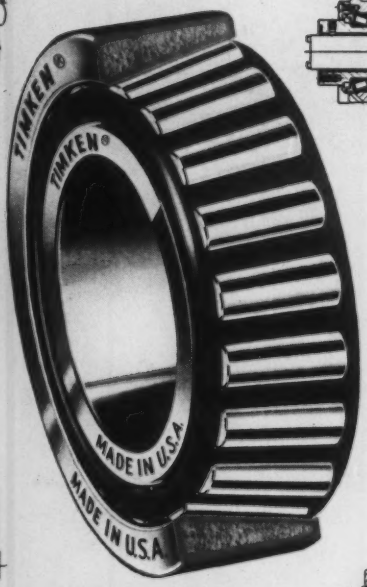

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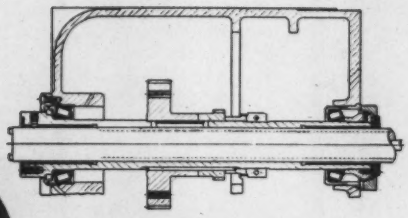

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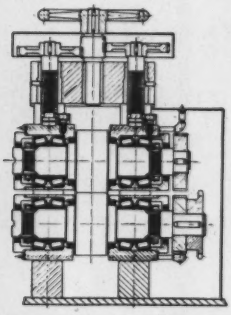

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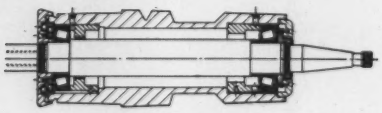

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3. The best-known name in bearings
4. Pace setter in lower bearing costs

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